
Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Public Use
Alternative A (Current Management)
Welsh Cove
Arboretum Drive
McIntyre Road
Existing Observation Platform
Ferry Way Trail
Gate
Electric Gate
Existing Observation Platform
Parking Lot
Hog Sty Cove
Former Weapons Storage Area
Office
Kiosk
Gate
Residence
Shop
Upper Powder Road
Nottingham Road
Hunt Safety Zone
Lower Powder Road
Thomas Point
RV pad
Caretakers House
Stubbs Pond
Stubbs Pond Road
Newington Road
Herods Cove
Woodman Point
Nanny's Island
Fabyan Point
Structure
Right of Way
Admin only Road
Entrance Road
Non-FWS Road
Public Trail
Chain link Fence
Miles
Kilometers

- Control any existing and new invasive plant species in the salt marsh using the most effective technique, which could include cutting, handpulling, biological controls, and herbicide application (e.g., cut and drop or spot treatment).

Participate in CWIPP's ongoing identification, monitoring, and eradication efforts for invasive plants in seacoast marshes.

Objective 1.2 (Intertidal and Shallow Estuarine Waters)

This objective is not part of our current management.

Objective 1.3 (Freshwater Impoundments)

Manage the 62 acres of freshwater impoundments (44-acre Stubbs Pond, 11-acre Upper Peverly Pond, and 7-acre Lower Peverly Pond) in a mosaic of approximately 50 percent emergent marsh (cattails, softstem bulrush, and arrowhead) and 50 percent open water to benefit migrating waterfowl, nesting marsh birds such as marsh wren, and migratory fish, including alewife and blueback herring.

Rationale
See rationale under alternative B, goal 1, objective 1.3.

Strategies
Continue to:

- Maintain 62 acres of freshwater impoundments of Stubbs Pond (44 acres), Upper Peverly Pond (11 acres), and Lower Peverly Pond (7 acres).
- Address structural deficiencies in Stubbs Pond and Upper Peverly Pond Dams, as indicated in chapter 2, under "Freshwater Impoundments."
- Prioritize and control invasive plants using mechanical, chemical, prescribed fire, and ecological methods. This includes removal of purple loosestrife, *Phragmites*, and brittle waternymph through water level manipulation and biological controls. Chemical controls are used as a last option if the other techniques are not effective.
- Provide and manage alewife habitat in Stubbs Pond and ensure passage through the dike for migratory fish, including alewife, American eel, and blueback herring.
- Use adaptive management to maintain an optimal mix of approximately 50 percent open water and 50 percent aquatic vegetation to benefit breeding and staging waterfowl, marsh and wading birds, fish, and rare plants.
- Control mute swans, a nonnative species that negatively impacts local plants and waterfowl.

GOAL 2.

Perpetuate the biological integrity, diversity, and environmental health of upland and forested wetland habitats on Great Bay Refuge to sustain native plant communities and wildlife, including species of conservation concern.

Objective 2.1 (Appalachian Oak-Hickory Forests)

Manage 659 acres of Appalachian oak-hickory forests dominated by red, black, and white oaks, and shagbark hickory, with less than 10 percent of total vegetative cover of invasive plant species to provide, breeding habitat for birds of conservation concern including scarlet tanager, Baltimore oriole, wood thrush, and other mixed-forest dependent species, and to maintain the exemplary natural communities of Appalachian oak-hickory forest on the refuge.

Rationale
See rationale for alternative B, goal 2, objective 2.1.

Strategies
Continue to:
- Assess habitat potential for the federally listed endangered Indiana bat, State-listed eastern small-footed bat, and other bat species.
- Complete a vegetation map for Fabyan Point and the Thomas property and update the natural community map for the rest of the refuge.
- Complete the inventory and mapping of invasive plants on the refuge.

Objective 2.2 (Forested and Scrub-Shrub Wetlands, and Vernal Pools)

Maintain the 149 of forested wetlands, scrub-shrub wetlands, and vernal pools on the refuge to sustain high water quality and to benefit foraging woodcock, breeding willow flycatcher and other birds of conservation concern, native plant communities, and wetland obligate amphibians, such as wood frog.

Rationale
See rationale for alternative B, goal 2, objective 2.2.

Strategies
Continue to:
- Complete the inventory and mapping of invasive plant species. Prioritize invasive species to be controlled and implement control using biological, ecological or cultural, mechanical, prescribed fire, or chemical, as needed.
- Evaluate the existing amphibian and reptile monitoring data, including the malformed frog surveys, to determine future monitoring needs.

Objective 2.3 (Upland Shrubland)

Manage the existing 26 acres of dry upland shrub habitat that supports native shrubs and young trees (e.g., highbush blueberry, black huckleberry, dogwoods, arrowwood , bayberry (*Morella spp.*), meadowsweet, raspberry, sensitive fern, sumac, and elderberry) to provide nesting and foraging habitat for migratory birds of conservation concern including prairie warbler, blue-winged warbler, eastern towhee, American woodcock, and other thicket-dependent species.

Rationale
See rationale for alternative B, goal 2, objective 2.3.

Strategies
Continue to:
- Complete the inventory and mapping of invasive plant species. Prioritize invasive species to be controlled and implement control using biological, ecological, mechanical, or chemical methods, as needed.
- Maintain the existing shrub habitats using mechanical tools, such as a brush hog or mower.

Objective 2.4 (Grassland)

Manage 169 acres of existing grassland habitat to benefit grassland nesting birds, including bobolink and upland sandpiper, and roosting American woodcock.

Rationale
See rationale for alternative B, goal 2, objective 2.4.

Strategies
Continue to:

- Maintain three large grassland fields (over 25 acres total) in the Weapons Storage Area and Thomas Field through annual mowing or burning after grassland bird breeding season, sometime after July 15.

- Maintain several other patches of open field:
  - The fields along the Ferry Way Trail as wildlife viewing sites
  - The leach field for administrative purposes
  - The area around old apple trees and historic sites at Woodman Point

- Complete the inventory and mapping of invasive plant species; prioritize invasive species to be controlled, and implement control using biological, ecological, mechanical, or chemical methods, as needed.

GOAL 3. **Foster and maintain conservation, research, and management partnerships to promote protection and stewardship of the ecological resources of the Great Bay Estuary.**

Objective 3.1 (Great Bay Partnerships)

Continue to actively participate in key partnerships to promote land conservation, stewardship, research and management of resources of concern within the Great Bay watershed. These partnerships include the Great Bay Resource Protection Partnership, Piscataqua Region Estuaries Partnership, Coastal Watershed Invasive Plant Partnership, and Pease Development Authority Wildlife/Bird Strike Hazard Committee.

Rationale
See rationale for alternative B, goal 3, objective 3.1.

Strategies
Continue to:

- Be an active member of the GBRPP and serve on the Principal Partnership and Stewardship Committees.

- Participate on the Pease Development Authority Wildlife/Bird Airstrike Hazard Committee.

- Serve on the PREP Management Committee.

- Participate in oil spill response training and coordination, particularly as a precaution in the unlikely event that an accident occurs with the shipping traffic up the Piscataqua River.

- Partner with the town of Newington, NHFG, and regional Service personnel on law enforcement on and around the refuge.

- Attend CWIPP meetings and actively participate in coordinated invasive species control and outreach efforts.

Objective 3.2 (Landscape-scale Conservation Partnership)

This objective is not part of current management.

Objective 3.3 (Education and Outreach Partnerships)

Support programs that engage youth and young adults in activities that advance wildlife conservation and refuge goals.

Rationale
See rationale for alternative B, goal 3, objective 3.3.

Strategies
Continue to:
- Partner with Youth Conservation Corps (YCC) program to mentor students and achieve refuge goals and objectives.
- Use the Student Temporary Employment Program (STEP) and Student Career Experience Program (SCEP) to mentor students and achieve refuge goals and objectives.
- Collaborate with Phillips-Exeter Sustainable Program.

GOAL 4. **Promote enjoyment and awareness of Great Bay Refuge and the Great Bay Estuary by providing high-quality, compatible, wildlife-dependent public uses on refuge lands and on partner lands and waters around the refuge.**

Objective 4.1 (Wildlife Observation and Photography)

Continue to maintain the existing two self-guided Peverly Pond and Ferry Way Trails to provide quality wildlife observation and photography opportunities on the refuge.

Rationale
See rationale for alternative B, goal 4, objective 4.1.

Strategies
Continue to:
- Pursue funding to construct a boardwalk along the entire Peverly Pond Trail to meet accessibility standards.
- Maintain the view from the Ferry Way Trail observation deck by pruning shrubs and brush that grow in over time.
- Maintain the kiosk and the parking lot.

Objective 4.2 (Environmental Education and Interpretation)

Provide limited environmental education and interpretive programs using volunteers when available.

Rationale
Although environmental education and interpretation are priority public uses, the lack of staff at the refuge limits our ability to offer any structured programs with regularity. We currently rely on volunteers to lead walks or other interpretive programs, which depends solely on their interest and availability. We continue to receive more requests than we can currently fill.

Strategies
Continue to:
- Use volunteers, if available and interested, to conduct occasional guided walks along the Upper Peverly and/or Ferry Way Trails.

Objective 4.3 (Hunting)

Continue to provide a quality annual deer hunt to manage the white-tailed deer population, protect habitat, and provide a priority wildlife-dependent recreational opportunity.

Rationale
See rationale for alternative B, goal 4, objective 4.3.

Bill Thompson

White-tailed deer

Strategies
Continue to:
- Work with NHFG to handle the permit applications for the existing refuge deer hunt.
- Maintain closure on recreational trapping on the refuge.

Objective 4.4 (Fishing)

Continue refuge closure to fishing, including in the three impoundments and from the refuge shoreline.

Rationale
See rationale for alternative B, goal 4, objective 4.4.

Strategies
Continue to:
- Keep refuge closed to fishing.
- Prohibit boats from landing on refuge shoreline.
- Conduct outreach about, and enforcement of, fishing closure and prohibit boats from landing.

GOAL 5.

Contribute to the recovery of the federally listed endangered Karner blue butterfly and other rare Lepidoptera through the conservation, protection, and restoration of pine barrens habitat.

Objective 5.1 (Habitat Management)

Maintain and manage the 29-acre conservation easement, comprised of pine barrens habitat for the Karner blue butterfly and other rare Lepidoptera in collaboration with the NHFG and other partners.

Rationale
See rationale for alternative B, goal 5, objective 5.1.

Strategies
Continue to:
- Compile current cultural resource inventories and identify additional survey work needed to protect cultural resources in conjunction with site plan implementation.
- Support NHFG with habitat management actions when and where resources allow.
- Post and maintain easement boundary and protect habitat from adverse impacts.
- Identify funding sources or mechanisms to maintain sufficient funding for habitat management.

Objective 5.2 (Species Management)

In collaboration with New Hampshire Fish and Game, support captive rearing and release of Karner blue butterflies to restore a viable population to the Concord pine barrens.

Rationale
See rationale for alternative B, goal 5, objective 5.2.

Strategies
Continue to:
- Support NHFG in captive rearing and translocation of butterflies through outlined partnership.
- Implement recovery plan actions, when and where possible.

Objective 5.3 (Outreach and Education)

Maintain existing outreach and education programs that engage youth and volunteers in the conservation of the Karner blue butterfly and the pine barrens habitat.

Rationale
See rationale for alternative B, goal 5, objective 5.4.

Strategies
Continue to:
- Maintain the existing kiosk.
- Partner with the "Kids for Karners" program in the Concord schools, coordinated by NHFG and National Wildlife Federation.
- Support existing partnership with the New England Zoo and Aquarium Association to engage volunteers in conservation of local species through activities such as native plant propagation, transplanting, trail construction, and outreach.

Objective 5.4 (Land Protection)

This objective is not part of current management

Objective 5.5 (Partnerships)

This objective is not part of current management

Alternative B–Habitat Diversity and Focal Species Emphasis (Service-preferred Alternative)

Alternative B, the Service-preferred alternative, combines the actions we believe would best achieve the purposes, vision, and goals of Great Bay Refuge, and respond to public issues. It emphasizes the management of specific refuge habitats to support focal species whose habitat needs benefit other species of conservation concern that are found around Great Bay and in the larger landscape of coastal New Hampshire. In particular, we would emphasize habitat for priority birds identified in BCR 30 such as migratory waterfowl, waterbirds, forest-dependent songbirds, shrubland species, and estuarine species of concern including oysters and eelgrass that are indicators of ecosystem health.

Along the Peverly Brook stream, we propose to implement activities to enhance water quality, improve habitat for migratory fish and shellfish, and maintain habitat for waterfowl, marsh birds, and other aquatic species. Specifically, under alternative B we propose removing the Lower Peverly Pond Dam to create stream habitat, while maintaining the dams at Upper Peverly Pond and Stubbs Pond to benefit a range of fish and wildlife. We believe that this combination of maintaining the largest freshwater impoundments and restoring a stretch of stream habitat enhances our contribution to protecting resources of concern in the Great Bay Estuary. In addition, alternative B addresses ongoing concerns of contaminant levels in the sediments within Upper Peverly Pond caused by previous land uses. We would expand our conservation, research, and management partnerships to help restore and conserve the Great Bay estuarine ecosystem and to address emerging issues, including climate change and landscape-scale conservation.

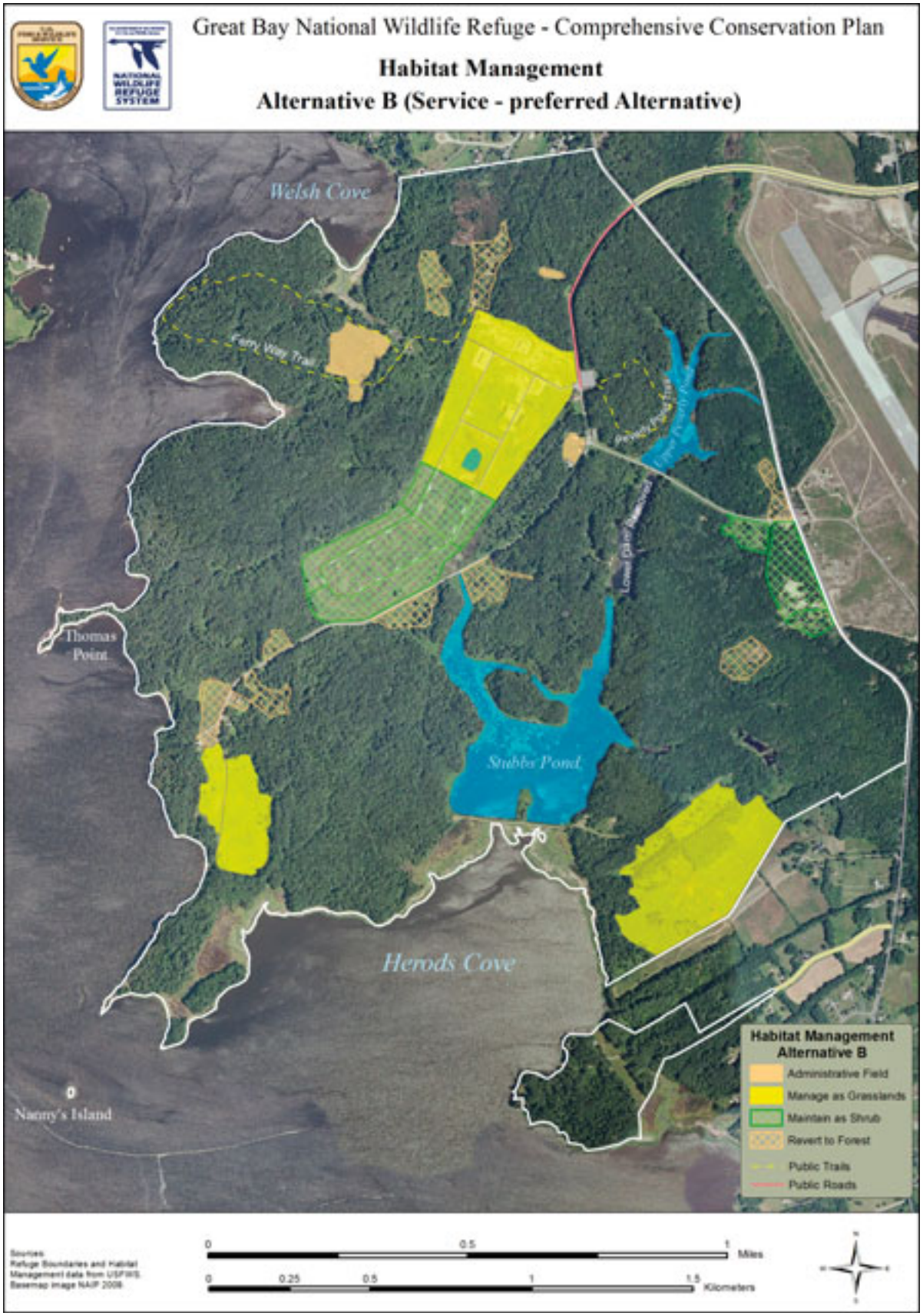
Under alternative B, we propose the following habitat restoration projects in the former Weapons Storage Area. We would manage approximately half of the area as shrubland as a possible location for establishing a captive breeding program for New England cottontail, a Federal candidate species. We would manage the other half as grassland to provide nesting habitat for upland sandpipers and other grassland species of conservation concern. We would also evaluate the underground bunkers for their potential as bat hibernacula.

This alternative would enhance our visitor services programs, which has been limited under current management due to lack of staff. We propose to enhance the entrance to the refuge, create new interpretive materials, expand on an existing quality volunteer program, and offer visitors more opportunities to learn about the refuge and the surrounding environs. We would evaluate expansion of hunting opportunities to include wild turkey. These expanded programs would be possible through the proposed increased staffing and new refuge headquarters/visitor contact facility addressed earlier in chapter 3.

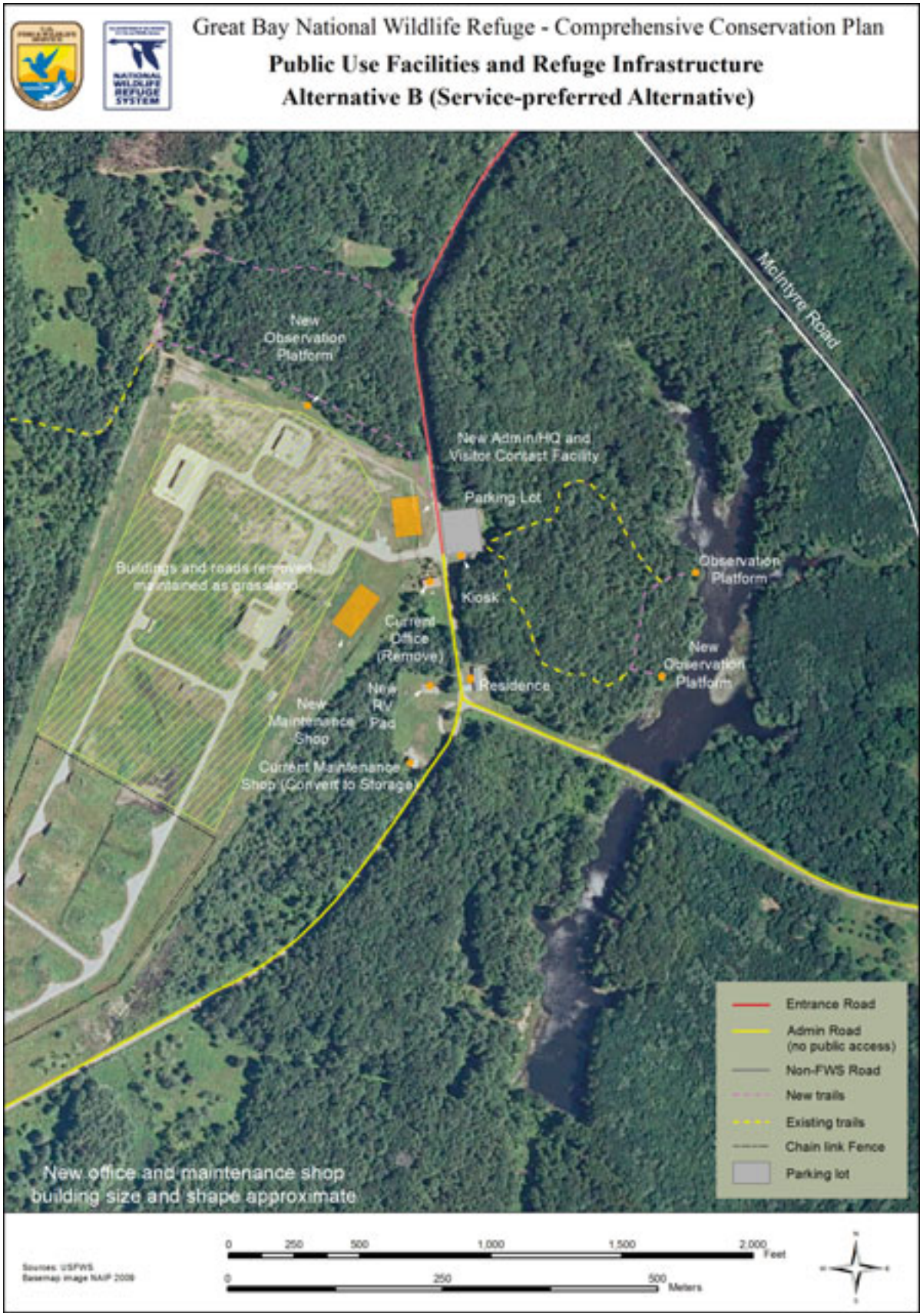
The habitat types that would result under alternative B are depicted on map 3.8. Maps 3.9 and 3.10 show refuge infrastructure and facilities, including those that would support the refuge's public use program, under alternative B.

GOAL 1. **Perpetuate the biological integrity, diversity, and environmental health of estuarine and freshwater habitats on Great Bay Refuge to protect water quality and sustain native plant communities and wildlife, including species of conservation concern.**

Objective 1.1 (Salt Marsh) Annually, maintain the quality and natural function of the 36 acres of salt marsh that supports a mix of native high and low marsh plant species including smooth cordgrass, salt meadow cordgrass, spikegrass, and black grass, with less than 1 percent overall cover of invasive plants, to provide habitat for breeding salt marsh sparrow, wintering American black ducks, foraging wading birds, fish, shellfish and rare plants.


Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Habitat Management
Alternative B (Service - preferred Alternative)
Welsh Cove
Ferry Way Trail
Lower Dyer Road
Thomas Point
Stubbs Pond
Herods Cove
Nanny's Island
Habitat Management Alternative B
Administrative Field
Manage as Grasslands
Maintain as Shrub
Revert to Forest
Public Trails
Public Roads
Sources:
Refuge Boundaries and Habitat Management data from USFWS.
Basemap image NAIP 2008
0
0.5
1
Miles
0
0.25
0.5
1
1.5
Kilometers


Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Public Use - Existing and Proposed
Alternative B (Service - preferred Alternative)
Welsh Cove
Arboretum Drive
New bike path connecting McIntyre Rd with Arboretum Drive
McIntyre Road
New Observation Platform
Existing Observation Platform
Existing Observation Platform
Ferry Way Trail
New Observation Platform
Big Sky Cove
Parking Lot
Kiosk
Office
Residence
RV Pad
Shop
Upper Pearly Road
Pearly Road
Nottingham Road
New Observation Platform
Thomas Point
Caretakers House
Stubbs Pond
Stubbs Pond Road
Newington Road
Herods Cove
Woodman Point
New Observation Platform
New Parking Lot and Trailhead
Fabyan Point
Nanny's Island
Refuge Boundary
Entrance Road
Proposed Entrance Road
Admin Road
(No public access)
Non-FWS Road
Right of Way
Existing Trail
Proposed Trail
Sources
Refuge Boundaries and Public Use data from USFWS
Basemap image NAIP 2009
0
0.5
1
Miles
0
0.25
0.5
1
1.5
Kilometers


Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Public Use Facilities and Refuge Infrastructure
Alternative B (Service-preferred Alternative)
McIntyre Road
New Observation Platform
New Admin/HQ and Visitor Contact Facility
Parking Lot
Buildings and roads removed, maintained as grassland
Kiosk
Current Office (Remove)
Observation Platform
New Observation Platform
Residence
New RV Pad
New Maintenance Shop
Current Maintenance Shop (Convert to Storage)
New office and maintenance shop building size and shape approximate
Entrance Road
Admin Road (no public access)
Non-FWS Road
New trails
Existing trails
Chain link Fence
Parking lot
0 250 500 1,000 1,500 2,000 Feet
0 250 500 Meters
Sources: USFWS
Basemap image NAIP 2008

Rationale
Several areas of salt marsh occur along the refuge shoreline, with the most extensive located near Woodman Point and Stubbs Pond. The low salt marsh is dominated by smooth cordgrass, while salt meadow cordgrass, spikegrass, and black grass are dominant in the high salt marsh. A healthy population of seaside mallow, a State-listed threatened plan, is found in the salt marsh near Woodman Point (NHB 2009). The salt marsh is relatively free of invasive plants, with the exception of patches of *Phragmites* adjacent to Stubbs Pond.

Up to 80 percent of the marshes that once occurred in New England have been lost to human development. The remaining salt marshes are being rapidly degraded by fragmentation and development (Bertness et al. 2002). Most of the salt marshes in New England, including those found around Great Bay were parallel ditched for mosquito control and to facilitate salt marsh haying. Salt marshes in the Great Bay Estuary occur as expansive meadow marshes and narrow fringing marshes. These marshes provide cover and forage habitats for fish, invertebrates, and birds, stabilize shorelines and protect against storm damage, and filter nutrients (Mills 2009). Protecting the remaining salt marshes is important to sustain habitat benefits, ecosystem services, and wetland functions.

In 1992, prior to refuge establishment, the town of Newington hired a contractor to spray the pesticide *Bacillus thuringiensis israelensis* (BTI) on marshes to control the extensive mosquito breeding occurring in areas of the marsh heavily impacted by humans. Beginning in 1996, in an effort to eliminate chemical application on the marshes and restore fish and wildlife habitat, the refuge initiated four Open Marsh Water Management (OMWM) projects. In total, 5.1 acres were implemented at Stubbs Pond, 11.25 acres at Herods Cove, 9.9 acres at Woodman Point, and 3.4 acres at Welch Cove. Project objectives included eliminating invasive plants (*Phragmites* and cattails) restoring native salt marsh vegetation such as widgeon grass, and creating suitable habitat for the mummichog minnow. The mummichog is a native predator of mosquito larvae; a healthy population eliminates or minimizes the need to spray BTI for mosquito control (University of Delaware, 2008).

Various open marsh and water management techniques were used. Ditch plugs were constructed to block man-made drainage ditches and create open water habitat. Pannes (beginning at a depth of 2 inches and gradually sloping to 24 inches) were excavated to increase open water habitat and to facilitate wading bird access. Sumps (2-foot-deep depressions) were excavated within pannes to ensure minnow survival during drought conditions. In some areas, shallow connector ditches were also excavated to allow minnow access between pannes.

As presented in chapter 1, the Service's policy on maintaining biological integrity, diversity and environmental health guides our conservation and protection of the broad spectrum of fish, wildlife, and habitat resources found on refuges (*http://www.fws.gov/policy/601fw3.html,* accessed May 2011*).* A major principle underlying this policy is to maintain and restore the diversity, structure, composition, and functioning of the refuge's fish, wildlife, and plant species, communities, and ecosystems, as well as biotic and abiotic processes that shape them. By developing an index of ecological integrity for the refuge's salt marshes, we will be able to gather baseline data and measure our success in sustaining and improving their biological integrity, diversity, and environmental health over time.

Coastal salt marshes provide breeding habitat for black ducks. Specifically, coastal marshes, estuaries, and sheltered coves are especially important foraging

habitat and shelter for black ducks in the winter (Dettmers 2006). On average, about 75 percent of New Hampshire's coastal wintering waterfowl gather on Great Bay, including nearly all of the State's Canada geese, greater scaup, and lesser scaup populations, as well as several thousand black ducks (Vogel 1995). The black duck is a globally vulnerable watch list species and is considered one of the highest priority species of concern according to the Atlantic Coast and Eastern Habitat Joint Ventures and among the state and provincial agencies where it occurs.

Virginia rail, red-winged blackbird, sora, salt marsh sparrow, and Nelson's sparrow nest and forage in salt marshes around Great Bay (Mills 2009). The salt marsh sparrow is a species of concern in New Hampshire and of highest conservation concern in BCR 30. The NHNHB Report (2009) documents an observation in 1997 of eight salt marsh sparrows; two were feeding young in the salt marsh at Woodman's Point. Flooding, particularly during new moon tides, is the primary cause of nest failure for the salt marsh sparrow, which is synchronized to nest immediately after a new moon tide. Vegetation structure and composition are less important in predicting nest success. Females wedge or suspend a nest in medium-high cordgrass just above the substrate or water near the mean high-tide line (Greenlaw and Rising 1994). Another potential threat to this species is elevated mercury levels, which were detected in salt marsh sparrows at other coastal National Wildlife Refuges (Lane 2008). Walsh et al. (in press) found the population at Chapman Landing, on the west side of Great Bay, was the most genetically differentiated from all populations sampled from Maine to Long Island.

According to the NHDES–Coastal Program (2005a), New Hampshire's salt marshes also provide habitat for other aquatic species, including a wide variety of fish and shellfish (e.g., American eel, mummichog, Atlantic silverside, nine-spine stickleback, shore shrimp, and sand shrimp). Several mammals also use salt marsh habitat including deer, muskrat, river otter, and red fox (NHDES 2005b).

Strategies

Continue to:

- Control any existing and new invasive plant species in the salt marsh using the most effective technique, which could include cutting, hand pulling, biological controls, and herbicide application (e.g., cut and drop or spot treatment).

- Participate in the CWIPP's ongoing identification, monitoring, and eradication efforts for invasive plants in seacoast marshes.

- Prohibit public access to salt marsh habitat on refuge.

Within 3 years of CCP approval:

- Develop an index of ecological integrity to
  (1) determine the current baseline integrity condition;

  (2) determine what areas of integrity are low and need attention; and

  (3) prioritize management actions to ensure that the index does not fall below the baseline level. The index's parameters may include vegetation richness and diversity, elevation, sediment accretion, salinity, extent of tidal fluctuation, and water quality measures.

- Evaluate all salt marshes that received OMWM to determine ecological integrity of the marshes, with special emphasis on hydrology, climate change impact,s and invasive plants.

- Collaborate with partners to assess the salt marsh sparrow population around the bay and determine the relative importance of the refuge population to the Great Bay ecosystem and to the larger regional population. Also, partner with UNH to determine how the refuge salt marsh sparrow population fits in the metapopulation structure in New England and throughout the species' range.

- Work with GBNERR to identify and address sources of mercury entering Great Bay, to the extent possible.

- Collaborate with GBNERR on their efforts to establish vertical benchmarks in various low-elevation habitat types within the Reserve. Promote placing one or more on the refuge. Regular surveying of these benchmarks, coupled with enhanced data from tide gauges, will enable accurate tracking of local sea level rise and anticipate its effects on habitats within the Great Bay ecosystem.

- Provide information to refuge visitors about the environmental sensitivity and importance of salt marsh to the health of the Great Bay Estuary.

- Implement an "early detection rapid response" program that would prevent new invasive species from becoming established within the freshwater tidal marsh by locating newly established invasive species and immediately addressing those populations through the appropriate control measure. This program would incorporate a combination of plant identification and inventories, maintaining updates of new invasive species present in the region, as well as having knowledge of the appropriate management techniques prior to conducting control efforts.

- Assess the distribution and health of rare plant populations.

- Work with partners to develop and implement a monitoring plan to identify breeding activities, abundance, and densities of salt marsh sparrows in Great Bay, inclusive of the refuge.

- Partner with BRI or other organizations to test if mercury levels are high in the refuge's salt marsh sparrow population, as one indicator of ecological health.

- With volunteers and partners, conduct fall waterfowl migration surveys, and mid-winter waterfowl surveys to the extent access is possible, of black ducks and other waterfowl to assess the importance of the refuge to regional migrating populations.

- Assess the effects of the OMWM treatments to determine if they were successful in meeting objectives.

Monitoring Components

- Annually monitor the salt marsh habitat for presence of invasive plant species.

- Establish and implement monitoring protocol to track changes in salt marsh biological integrity against its baseline index.

- Work with GBRPP, GBNERR and other partners to use SLAMM or other modeling results to develop a monitoring program that will evaluate conditions in the region's salt marshes over the next 15 years with respect to climate change and sea level rise.

- Establish and implement monitoring protocol with partners to evaluate breeding success of salt marsh sparrows.
- Work with NHFG to monitor migrating and wintering waterfowl.
- Establish and implement monitoring program to assess health and distribution of rare plant populations.

Objective 1.2 (Intertidal and Shallow Estuarine Waters)

Work with partners to protect and restore the health and function of the intertidal habitats in Great Bay Estuary, including enhancing water quality to benefit fish, shellfish, breeding and wintering bald eagles and waterfowl, and other estuarine life, such as oysters, softshell clams, and horseshoe crabs. Emphasize the restoration and maintenance of 2 acres of oyster beds around Nannie Island and Woodman Point, and the eelgrass beds.

Refuge-specific support of regional objectives would include:

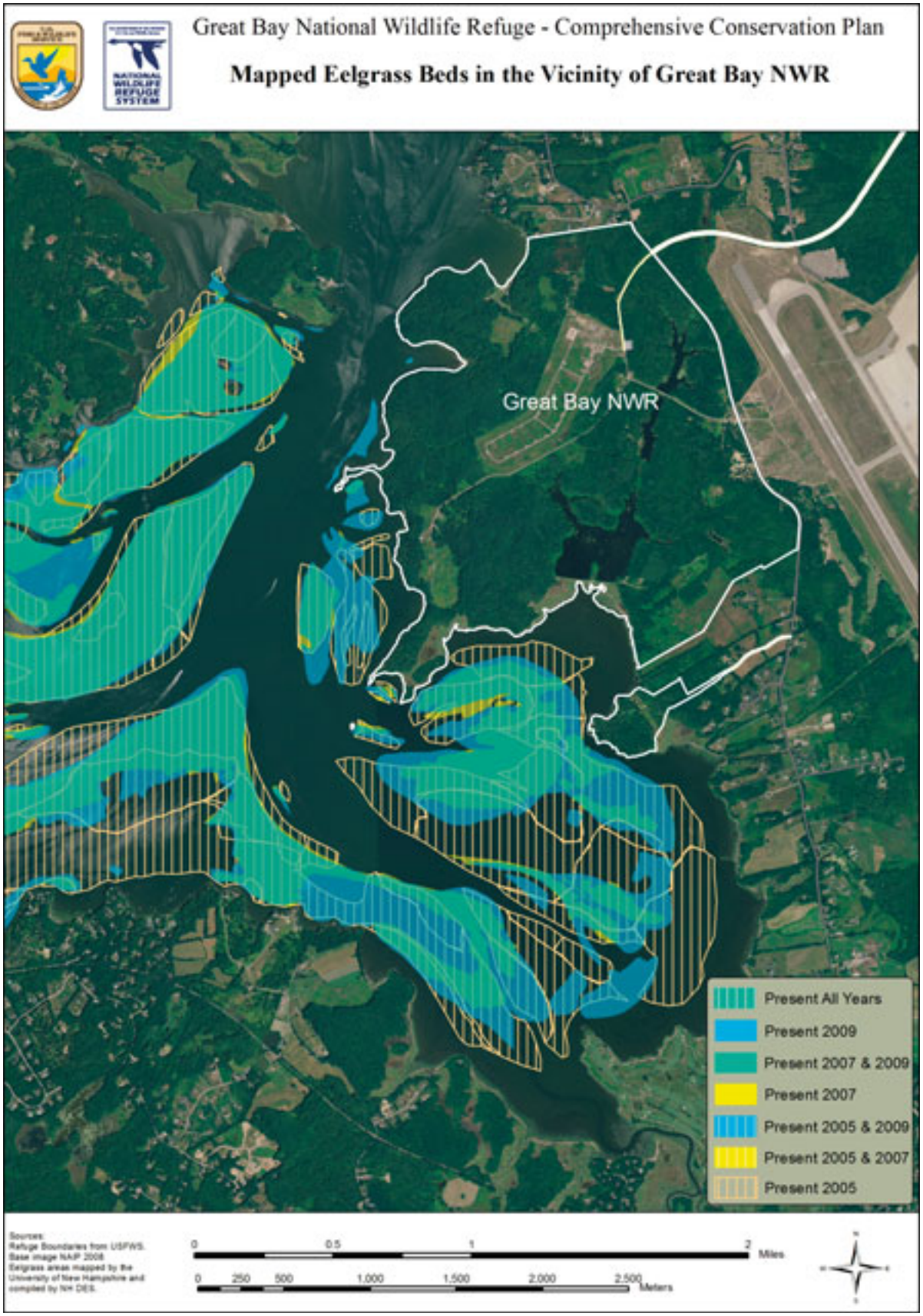
- Contribute to the PREP CCMP's goal of 50,000 bushel of adult oysters (greater than 3.2 inches) by 2020 by supporting 25,000 bushels of adult oysters in the Nannie Island area in the same time period.
- Contribute to the PREP CCMP's goal of restoring eelgrass cover to 2,900 acres and restoring connectivity of eelgrass beds throughout the Great Bay Estuary by 2020, by restoring the extent of eelgrass bed in Herod Cove and western shoreline of the refuge and increase eelgrass percent cover to a minimum of 60 percent for both beds.
- Contribute to protecting the water quality of the bay to provide migrating and watering habitat for waterfowl and breeding and wintering habitat for bald eagles. Support partner efforts to provide areas for waterfowl and bald eagles where they can nest, forage, and roost without human disturbance.

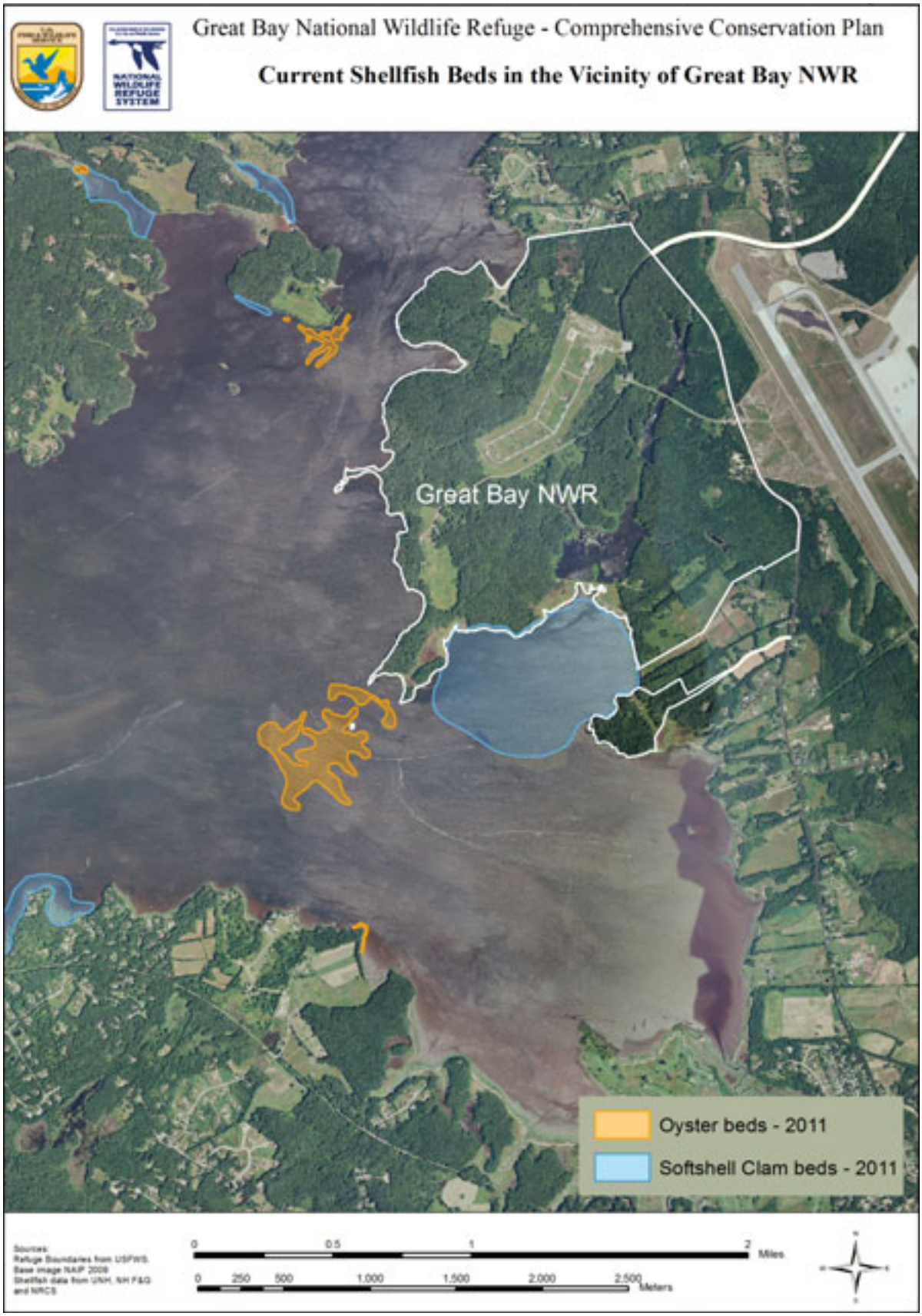
Rationale

Both eelgrass beds (map 3.11) and oyster beds (map 3.12) are regarded as keystone and indicator species for Great Bay Estuary. A keystone species is a species that plays a critical role in maintaining the structure and diversity of an ecological community and whose impact on the community is greater than would be expected based on its relative abundance or total biomass. Indicator species are plants and animals that, by their presence, abundance, lack of abundance, or chemical composition, demonstrate the quality of the environment.

Oysters, as long-lived filter feeders, are able to filter nutrients and pollutants to help maintain water quality and clarity in estuaries. Oysters accumulate in dense groups called beds or "reefs." These reef habitats provide homes or cover for other fish and crustaceans. Close to shore, oyster reefs serve as natural breakwaters, easing the impact of waves and boat wakes on shorelines.

Historical records document extensive oyster beds in most of Great Bay's tributaries and many channels within the bay. Hundreds of years of pollution, siltation, and harvest led to sharp declines in oysters throughout the bay (Mills 2009). More recent threats include two parasitic protozoans, *Haplosporidium nelson* (MSX) and *Perkinsus marinus* (Dermo). A major decline of oysters in Great Bay beginning in the early 1990s is thought to be caused by these protozoans. The population fell from 125,000 bushels in 1993 to 6,174 bushels in 2000; the population has since recovered to 10,044 bushels (PREP 2009).


Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Mapped Eelgrass Beds in the Vicinity of Great Bay NWR
Great Bay NWR
Present All Years
Present 2009
Present 2007 & 2009
Present 2007
Present 2005 & 2009
Present 2005 & 2007
Present 2005
Sources:
Refuge Boundaries from USFWS.
Base image NAIP 2008.
Eelgrass areas mapped by the University of New Hampshire and compiled by NH DES.
0
0.5
1
2
Miles
0
250
500
1,000
1,500
2,000
2,500
Meters


Great Bay National Wildlife Refuge - Comprehensive Conservation Plan
Current Shellfish Beds in the Vicinity of Great Bay NWR
Great Bay NWR
Oyster beds - 2011
Softshell Clam beds - 2011
0
0.5
1
2
Miles
0
250
500
1,000
1,500
2,000
2,500
Meters

PREP established a management goal of 50,000 bushels of adult oysters or 10 million adult oysters by 2020 (PREP 2010). The largest oyster bed in Great Bay is located near Nannie Island, supporting almost 100,000 bushels of adult oysters in 1993 (map 3.12) (PREP 2009). This reef declined in area by 33 percent between 1997 and 2000, while a much smaller bed at Adams Point expanded by over 200 percent during the same period. In 2007, UNH constructed 12 mini-reefs (from recycled oyster shells), seeded with 1.2 million oyster spats, in a 1.75 acre area just north of Nannie Island. The Nannie Island restoration area experienced increased oyster densities from 2007 to 2009 due in large part to the exceptional 2006 natural recruitment observed throughout Great Bay (PREP 2009). Oysters filter about 20 gallons of water per day, which has major implications for the health of the Great Bay Estuary. In 1970, the oyster population could filter the estuary's water in 4 days. Today, with the reduced population, it takes 100 days or more (Mills 2009).

Eelgrass is an essential habitat in Great Bay Estuary and the basis of an estuarine food chain, providing food for migrating and wintering waterfowl and habitat for juvenile fish and invertebrates (map 3.11). In winter, eelgrass is dormant with much of its energy reserves tied up in the underground root or rhizome. This carbohydrate-rich food source is relished by wintering geese and ducks (Smith 2004). Eelgrass beds are particularly important to juvenile rainbow smelt, Atlantic silversides, nine-spined sticklebacks, alewife, and blueback herring. Larger fish and wading birds are attracted to the smaller fish that hide within the eelgrass beds. The long narrow leaves of eelgrass slow water flow and filtering suspended sediments from the water column (Short et al. 1992a).

A dramatic decline in eelgrass beds in 1989 to only 300 acres was linked to an outbreak of a slime mold (*Labryrinthula zosterae*), commonly called "wasting disease." Although the eelgrass beds recovered from the outbreak on up to 2,000 acres in 1996, the eelgrass beds are again in a slow and steady decline. Between 1990 and 2008, the eelgrass cover in Great Bay declined by 37 percent and eelgrass biomass by 64 percent. By 2008, eelgrass was gone from Little Bay, the Winnicut River, and almost entirely from the Piscataqua River (PREP 2010). Eelgrass beds remain offshore from the refuge, although greatly diminished from 1996. The loss of eelgrass beds has major implications for the health of the Great Bay Estuary, affecting water quality and habitat suitability for eelgrass-dependent species. Nutrient loading and increased turbidity from suspended sediments are considered two of the limiting factors to restoring eelgrass to the bay (PREP 2009).

Softshell clams are another important food source for wintering waterfowl, particularly diving ducks (map 3.12). A large clam flat is located in Herods Cove. Clam populations in Great Bay have fluctuated due to harvest pressures, invasive predators (such as the nonnative green crab) and diseases (such as "neoplasia"). Another interesting invertebrate found in Great Bay is the horseshoe crab, which is not a true crab. Horseshoe crabs spawn in late spring and early summer on the shores of Great Bay. In some places along the East Coast, horseshoe crab eggs are a valuable food source for nesting terns and wading birds and migrating shorebirds. Their distribution and ecological role in the Great Bay Estuary is unclear.

The bay is one of the primary bald eagle wintering areas in New Hampshire, contributing roughly 20 percent of the total eagles counted in the State during the mid-winter bald eagle survey (Martin 2011, personal comm). Eagles use large trees on the refuge, particularly dead or alive white and red pine as daytime perches, roost sites, and for nesting. As of 2010, there were 14 total nesting pairs of bald eagles in the State (NH Audubon 2010). In 2011, a pair of bald eagles nested on the refuge adjacent to the bay, and successfully fledged one chick. This

is the first time in decades that bald eagles have nested on the refuge. The bay also supports the largest concentration of wintering waterfowl in the State, with thousands of waterfowl using the bay at any one time. To provide undisturbed habitat for waterfowl and eagles, the refuge restricts public access to the shoreline.

Strategies

Continue to:

- Organize annual shoreline cleanup on the refuge with the help of volunteers.
- Restrict public access to the shoreline to provide buffer and undisturbed roosting, foraging, and breeding habitat for waterfowl and bald eagles.

Within 3 years of CCP approval:

- Begin working with NHFG and other Great Bay partners to restore oyster beds near Nannie Island and Woodman Point. This includes assessing the current status of the oyster reef and restoring the reef through existing or experimental methods such as augmenting the reef with spent clam shells or other material and seeding with oyster "spat" (young oysters).
- Begin working with NHFG, UNH, and other Great Bay partners to restore eelgrass bed west of Woodman Point and at Herods Cove. This includes assessing the current extent and percent cover of eelgrass beds and restoring beds by transplanting eelgrass.
- Begin working with NHFG, NHDEs, and Great Bay partners to reduce nutrient and sediment loading into Great Bay, which affects water quality and in turn affects oysters, eelgrass, and other aquatic life, with particular emphasis on oyster and eelgrass beds in Herods Cove.
- Work with NHFG to protect the clam flats in Herods Cove from overharvest through cooperative enforcement of State regulations on shellfish harvesting.
- Study the importance of the refuge shoreline as spawning and nursery habitat for horseshoe crabs; partner on assessing the health of horseshoe crab population in the estuary.
- Assess the need for additional protection for nesting bald eagles from human disturbance. If necessary, work with NHFG and other partners to provide additional buffer from recreational bay user.

Monitoring Components

- Work with partners to monitor the health and distribution of the oyster beds near Nannie Island and Woodman Point.
- Assess the Herod Cove clam flat to determine area of clam bed, density, and populations.
- Work with partners to monitor the health and distribution of eelgrass beds near the refuge.
- Work with partners to monitor the presence of nonnative invasive aquatic organisms, such as the green crab, to minimize impacts on native shellfish.
- Conduct annual horseshoe crab surveys at spawning sites on Great Bay, consistent with approved State or regional protocols. Shoreline protocols are currently being developed by the University of Rhode Island and the State of New Hampshire.

- Work with and GBNERR and PREP to monitor water quality within the Great Bay Estuary as indicator of ecological health.

Objective 1.3 (Freshwater Impoundments and Peverly Brook System)

Manage the 62-acre Peverly Brook system on the refuge to improve water quality, establish a more natural flow regime, improve migratory and resident fish habitat, and maintain habitat for waterfowl, marshbirds, and other aquatic life.

Objective 1.3a (Stubbs Pond)

Annually manage the existing 44-acre Stubbs Pond to maintain a diversity of native emergent marsh vegetation (e.g., cattails, arrowhead, wild rice, and softstem bulrush) with 30 to 50 percent open water and less than 5 percent invasive plant species (e.g., purple loosestrife and *Phragmites*) to benefit migrating waterfowl such as black duck, nesting marsh birds such as marsh wren and Virginia rail, raptors such as bald eagles and osprey, and migratory fish, including American eel, alewife, and blueback herring. Specific habitat targets include:

- Annually support migratory waterfowl through a mix of water depths, flooded vegetation (cattail, wild rice, and softstem bulrush) at peak fall migration (late October).

- Annually maintain a high water level in Stubbs Pond during the summer months to maintain 50 to 70 percent native emergent vegetation (cattail, wild rice, and softstem bulrush), and to provide breeding habitat for marsh and wading birds.

- Annually provide migratory fish (alewife and blueback herring) access to spawning habitat in Stubbs Pond by maintaining a minimum of 1.0 feet of running water through the fish ladder structure from late April to mid-July, or until water level is insufficient for fish passage.

Objective 1.3b (Upper Peverly Pond)

Annually maintain the existing 11-acre Upper Peverly Pond to provide wildlife observation opportunities, and to benefit migrating waterfowl, including wood duck, ring-necked duck, and green-winged teal, and to provide nursery habitat for American eel. Establish evaluation criteria, and regularly evaluate the environmental conditions of this pond to determine the desirability and feasibility of its future removal.

Objective 1.3c (Lower Peverly Pond)

Within 5 years of CCP approval, remove the failing dam and other associated infrastructure at Lower Peverly Pond, and restore the existing 7-acre pond to 1,100 feet of native riparian habitat, reconnecting a portion of a fragmented river system, reestablishing natural streamflow, and enhancing habitat for migratory native fish.

Rationale

The 1.52-mile Peverly Brook begins a few thousand feet north of the refuge boundary. The 907-acre watershed is the largest watershed in the town of Newington and was once a drinking water source for the city of Portsmouth. The city diked Peverly Brook around 1900 to serve as a water supply, creating Upper and Lower Peverly Ponds. The Air Force acquired the lands encompassing Peverly Brook in 1952 and managed the three freshwater impoundments for mosquito control and recreation. We describe the history of the impoundments under Air Force ownership in chapter 2 in the section on “Freshwater Impoundments.”

According to the Service's New England Ecological Services Field office (NEFO), contaminants have not migrated any lower down the watershed and the contaminant levels in Lower Peverly and Stubbs Ponds meet clean-up goals (Drew Major, NEFO, personal communication). However, prior to any dam removals we would conduct additional sediment and water quality testing to ensure safe levels.

Since refuge establishment, the three impoundments in the Peverly Brook drainage have been managed primarily to benefit spring and fall migrating waterfowl and marsh nesting birds. Under alternative B, we would expand our management to include enhancing water quality, improving habitat for migratory and resident fish, and maintaining habitat for waterfowl, marsh birds, and other aquatic life. Specific strategies will be detailed in the HMP, such as water level management (e.g., timing, season, and desired water level) and invasive species treatments.

In chapter 2, in our discussion on freshwater impoundments, we provide a summary of the 2006 SEED report which identified concerns with the three impoundment infrastructures, but also included recommendations for improvement. Our summary in chapter 2 also includes what work we have been undertaking to date to address those concerns and implement recommendations.

Stubbs Pond: As part of this CCP process, we reviewed the benefits and consequences of maintaining Stubbs Pond as a freshwater impoundment versus breaching the dike and restoring it to a saltwater system. According to NHFG, Stubbs Pond is unique within the Great Bay Estuary system, given its large size (44 acres of freshwater wetland) and established population of wild rice. There are no other places in coastal New Hampshire that draw in the amount and diversity of waterfowl documented at Stubbs Pond, especially mallards and black ducks during spring and fall migration (Ed Robinson, Waterfowl Biologist, NHFG, personal communication). A recent study commissioned by the Service reported that Stubbs Pond is unlikely to be affected by sea level rise as a result of climate change (Clough and Larson 2009), although more detailed analysis is needed.

Water level manipulation is used in Stubbs Pond to manage the ratio of vegetation to open water and to control undesirable vegetation including invasive plants. The objective is to control the monoculture of cattail vegetation and increase vegetation diversity, opening up areas to increase the ratio of open water to emergent vegetation while controlling invasive purple loosestrife and common reed. Water level management has fluctuated from year to year, in part because of the difficulties in managing Stubbs Pond. A new water control structure was installed in 1996. Since then, refuge staff have used various techniques to control excessive cattail growth and to strive for a 50:50 balance of aquatic vegetation and open water. Techniques included mowing, manipulating water levels (drawdowns and flooding), use of herbicides on cattails, and release of *Galerucella* beetles to control purple loosestrife. The State-listed plant large bur-reed, is found in Stubbs Pond.

After several years of implementing these techniques, refuge staff concluded that spring drawdown of Stubbs Pond allows cattail and purple loosestrife to increase, while inhibiting other more desirable species, such as large bur-reed, soft stem bulrush, wild rice, wild celery, and arrowhead. Our experience indicates that Stubbs Pond should be kept relatively high during the spring and summer to discourage cattail growth. A drawdown in early fall benefits migratory birds. If weather permits, it may be possible to mow, spray, or burn cattail stands in the fall before refilling the pond in the winter to early spring.

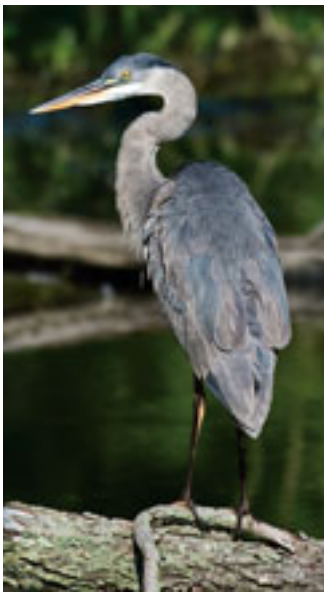
A fish passage structure was installed in 1995 in Stubbs Pond but was not operated until the spring of 2003. The fish passage is now opened in late April to allow alewife and blueback herring migration into Stubbs Pond during May. Five years (1999 to 2003) of marsh bird surveys were conducted on the refuge. Virginia rail, least bittern, sora, common gallinule, pied-billed grebe, king rail, and marsh wren were recorded in Stubbs Pond. The amount of emergent wetland habitat has declined significantly throughout North America along with apparent declines of marsh-dependent birds. Changes in water levels, ratios of mud flats to open water areas, invertebrate communities, and amount of emergent plant cover in marsh habitats could affect habitat quality for marsh birds. Given the variability of rainfall, annual vegetation changes, and the varying needs of priority species, we would continue to use adaptive management and annually modify water levels as needed to create appropriate seasonal habitat conditions for the full suite of species, including waterfowl, marsh birds, and migratory fish.

In order to establish a baseline and improve our water level management in Stubbs Pond, we propose to map the bathymetry (the underwater elevations) of Stubbs Pond, relative to the dike, spillway, fish ladder, water control structure, brook, and salt marsh. This information would help us determine how to manipulate the pond's water levels to meet our objectives for migratory birds, fish passage, and other resource values. It would also help us establish a baseline from which to measure changes that might occur due to climate change, such as sea level rise or other processes that might result in subsidence or deposition in areas.

We also propose to work with partners to evaluate the effectiveness of the fish ladder and determine if there are practicable opportunities to enhance the movement of fish migrating through. Examples of improvements that have been recommended, but need further analysis, include the following:

- Creating an attraction jet to guide fish to the ladder.
- Installing a nature-like bypass to provide additional passage for American eel, alewife, and blueback herring.
- Install additional sections of the "steeppass" ladder.
- Determine if a new design or retrofit could allow fish to pass at a greater range of tides.

Great blue heron



USFWS

The existing fish ladder was designed to only pass fish at high tide because at lower tides fish cannot cross the tidal mudflats to reach the ladder. It would be very difficult and costly to provide fish passage at a wider range of tide levels (Brownell, personal communication, 2011).

<u>*Upper Peverly Pond:*</u> Upper Peverly Pond is used as a foraging and resting site during migration by a small number of waterfowl and marsh and wading birds (great blue heron, wood duck, bufflehead, ring-necked duck, and green-winged teal). It provides nursery habitat for American eel during its elver stage. American eel is a declining species that spends most of its life in fresh or brackish water, then travels downstream and far offshore to the Sargasso Sea where it spawns.

A new water control structure was installed on Upper Peverly Pond in 1999 to control water levels to benefit waterfowl. The pond was drawn down several times during spring for moist soil management with positive vegetative and waterfowl population response to this management. The vegetation in and around Upper Peverly Pond seems to be more stable than in Stubbs Pond. In 2004, the

invasive brittle water nymph was discovered in Upper Peverly Pond. Brittle water nymph is an annual invasive plant with no easy control methods. Upper Peverly Pond is a maintained primarily as open water habitat, with minimal water level management.

We propose to maintain the dam on Upper Peverly Pond for several reasons. There are still contaminated sediments remain in Upper Peverly Pond pond and trapped behind the dike. We are concerned that removal of the dam in the near future would release these sediments downstream with unknown environmental impacts and would likely diminish habitat for American eel as well as waterfowl. However, we propose to establish evaluation criteria, and regularly evaluate the environmental conditions of this pond to determine the feasibility of its future removal.

Lower Peverly Pond: The 7-acre Lower Peverly Pond has an antiquated spillway that is deteriorating and has no water control capabilities. Also, beaver activity in the area is significantly affecting the integrity of the dam and accelerating the likelihood of total failure. The current risk that the dam might fail is high. Under alternative B, we propose removing the dam at Lower Peverly Pond because of the expense to upgrade it to current safety standards, compared to the minimal value to Federal trust resources. The use of this pond by waterfowl, wading birds, and other species of concern is low. A limited number of waterfowl, including a few wood, black, and ring-necked ducks, and bufflehead, are seen during the spring and fall migration. We predict that we could recover and restore to near natural conditions approximately 1,100 feet of stream if the dam were removed.

Although removal of the Lower Peverly Dam might diminish some habitat for American eel, the presence of active beaver in the system will likely function similar to the existing dam, and might allow for improved eel passage (Douglas Smithwood, Fishery Biologist, USFWS, personal communication with Graham Taylor October 20, 2009). Furthermore, removal of the failing Lower Peverly Pond Dam is consistent with a proposal presented in a letter to the Service from the NHDES in 2007. That letter clearly stated that reconstruction of the dam would not be beneficial to aquatic life in Peverly Brook or Stubbs Pond. Rather, breaching the dam would remove the threat of dam failure and eliminate continued downstream erosion from the Lower Peverly spillway. The letter further noted that dam removal would improve the water quality in Peverly Brook and provide additional stream habitat for spawning blueback herring and other fish species. In addition, dam removal would be consistent with the Coastal Zone Management Act (Christian Williams, NH Coastal Program, personal communication, November 21, 2007).

Contaminant levels associated with the former Air Force Base have decreased enough that they are close to or meet clean-up targets. The Upper Pevely Pond Dam has acted as a sediment trap, preventing some contaminants from moving downstream. The removal of the Lower Peverly Pond Dam should not exacerbate any existing contaminant issues below Lower Peverly (Drew Major, Contaminants Specialist, NEFO, personal communication with Graham Taylor, Dec 12, 2009; see appendix I). We propose pre- and post-dam removal sampling to establish a baseline and measure any impacts to water and contaminants resulting from dam removal. Brittle waternymph was found in Lower Peverly Pond in 2004. We also propose to evaluate control methods prior to removal of the Lower Peverly Pond Dam.

We do not have a detailed plan for the dam removal at present. We would work with NHFG, NEFO, NHDES, and the Service's Central New England Fisheries Resource Office to coordinate the design. We will also consult with the SHPO

to determine if Lower Peverly Dam is eligible for the National Register and to minimize any potential impacts of its removal on cultural resources. We would expect the work would occur in late summer during low flow and drier conditions. Our concept would be to remove the concrete spillway using excavators and then use some of the earthen material to reconstruct and contour the uplands to begin restoration of a forested riparian area. Some recontouring of the stream channel would also likely be necessary to recreate the original stream channel and bed, or to approximate it the best we can. In our estimation, approximately 150 feet of stream reach would be included in the project area. We would hope to coordinate with the Coastal America program to implement the project.

Strategies

Continue to:

- Work with partners at the headwaters of the Peverly Brook system to improve water quality and ensure water quantity.

- Prioritize and control invasive plants (e.g., *Phragmites*, loosestrife, brittle waternymph) within the Peverly Brook system using mechanical (e.g., mowing), biological, chemical, prescribed fire, and ecological methods. Chemical controls are used as a last option if the other techniques are not effective.

- Use adaptive management in Stubbs Pond and Upper Peverly Pond to maintain an optimal mix of open water and aquatic vegetation (approximately 50 percent of each) to benefit breeding and staging waterfowl, marsh and wading birds, fish, and rare plants. Specific water level manipulations will be prescribed in the AHWP, based on existing conditions at the time.

- Annually maintain dikes, dams, spillways to ensure integrity of structure and address any items identified in the periodic SEED assessments (last done in 2006). Annually maintain and inspect water control structures and emergency valves (See "Freshwater Impoundments" section in chapter 2 for details on current and proposed maintenance of the dams).

- In partnership with NHFG, control mute swans, a nonnative species that negatively impacts local plants and waterfowl.

Within 3 years of CCP approval:

- Work with NHFG and the Service's Central New England Fisheries Program to evaluate effectiveness of the ladder and determine if there are practicable opportunities to enhance the movement of fish migrating through the ladder from late April to mid-July given the constraints of tidal flow and with consideration for maintaining quality, open water habitat for migratory birds.

- Work with Service's NEFO to monitor contamination and identify remediation options for Upper Peverly Pond. Develop evaluation criteria and regularly evaluate the environmental conditions of this pond to determine the feasibility of its future removal.

- Seek technical and financial assistance from partners with project design and implementation to remove the Lower Peverly dike and restore that section of the Peverly drainage. Consult with the SHPO to determine if Lower Peverly Dam is eligible for the National Register and to minimize any potential impacts of its removal on cultural resources. Work with NHFG, NHDES, NEFO, and the Service's Central New England Fisheries Program to plan/design removal of impoundment structure and restoration of brook, including stream channel and adjacent riparian area. Begin all requirements to obtain permits for the work.

- Prevent infestation of invasive species during and after the dam removal at Lower Peverly. Use early detection rapid response techniques.

- Complete bathymetry study of Stubbs and Upper Peverly Ponds to help refine impoundment management on those ponds.

- Re-locate, or construct an additional, osprey platform at Stubbs Pond in order to encourage nesting away from the dike and to minimize the disturbance to nesting birds caused by management activities.

Within 5 years of CCP approval:

- Assuming funding is secured, remove Lower Peverly Pond Dam and restore the existing 7-acre pond to stream and adjacent riparian habitat. Prior to dam removal:

  - Evaluate the extent of brittle waternymph in the impoundments and determine control methods.

  - Assess Lower Peverly Pond for water and sediment contamination. If levels do not pose a concern for refuge resources, begin required permitting process for dam removal.

  - Arrange assistance with Coastal America program to help during construction and restoration phase.

Monitoring Components

- Monitor water levels in Stubbs Pond and Upper Peverly Pond, 1 to 2 times per week, year-round as feasible (i.e., if open water).

- Check fish ladder several times a week from late April to mid-July and weekly from September to November for structural condition and fish use.

- Conduct a Water Resource Inventory and Assessment following the National Service standards to determine current water conditions (quality and quantity) and needed future monitoring.

- Weekly monitor osprey and bald eagle nest during nesting season.

- Conduct sediment and water quality monitoring in the Peverly Brook system from Lower Peverly to Stubbs Ponds to establish pre-dam removal baseline. One year after the removal of the Lower Peverly Dam, conduct post-dam removal monitoring impacts in Stubbs Pond.

- Annually monitor the migratory fish populations and movement in the Peverly Brook system.

- Monitor sediments and water quality in the Peverly Brook system for contaminants every 3 to 5 years.

- Develop a monitoring protocol to assess current habitat condition of Lower Peverly Pond and adjacent habitats, and monitor vegetation community change after dam removal.

- Develop a protocol for ongoing evaluation of Upper Peverly Brook to determine if pond should be dredged, maintained as is, or breached. Establish thresholds or triggers that would lead to a shift in management based on regional landscape context, contribution to Federal trust resource conservation, potential management implications and commitments, changes in visitor services, long-term solutions to contaminant issues.

- Map and monitor invasive plants in the Peverly Brook system, and update every 5 years.
- Work with the New England Wildflower Society and other partners to establish and implement a protocol for routine monitoring of rare plant populations documented by NHB in Stubbs Pond including large bur-reed and stout bulrush.
- Work with the Pease Airport Authority to establish regular monitoring of potential runoff from the airport into the Peverly Brook watershed, particularly potential runoff from the new de-icing pads.
- Collect baseline information on freshwater mussels in the impoundments and potential impacts from water level drawdowns and restoration.

GOAL 2. **Perpetuate the biological integrity, diversity, and environmental health of upland and forested wetland habitats on Great Bay Refuge to sustain native plant communities and wildlife, including species of conservation concern.**

Objective 2.1 (Appalachian Oak-Hickory Forests)

Maintain the biological integrity, diversity, and environmental health of the refuge's 700 acres of mature Appalachian oak-hickory forests to provide habitat for breeding and migrating birds of conservation concern including scarlet tanager, Baltimore oriole, wood thrush, and breeding and migrating forest bats. Ensure less than 10 percent of total vegetation cover is invasive plant species (e.g., common buckthorn, common barberry, glossy buckthorn, and winged euoynomous).

Rationale

In appendix B (part 1.3), we detail the process we used to determine what elements comprise the biological integrity, diversity, and environmental health for each of the refuge's plant communities. We reviewed historical conditions, site capability, the current regional landscape conditions, and the biological diversity on the refuge. We also considered natural processes and limiting factors which could potentially affect each plant community.

Many of the forests on Great Bay Refuge have a recent agricultural history and are dominated by successional white pine or hardwoods. Although pine, hardwoods, and mixed stands are clearly evident, the current overstory dominant tree species are not necessarily the best indicator of what natural community types occurred on the refuge. White pine stands are common and are generally a stronger indication of past land use history than they are of the long-term potential of a site. The NHB used the total composition of plant species, in combination with soil attributes, to indicate community type (Sperduto 2000).

Dry Appalachian oak forests are characterized by southern (or "Appalachian") species that reach the northern extent of their ranges in southeastern New Hampshire and southern Maine. The typical dominant trees in this forest type include a mix of oaks, such as red, black, and white oaks, and the somewhat less abundant shagbark hickory. The shrub layer is dominated by flowering dogwood, mountain laurel, and American hazelnut. Pennsylvania sedge may form extensive "lawns," contributing to a park-like setting. This community supports a high diversity of herbaceous plants, including numerous State rare species, such as sweet goldenrod, birdfoot violet, hairy bedstraw, reflexed sedge, slender knotweed, fern-leaved false-foxglove, Maryland tick-trefoil, and prostrate tick-trefoil.

The mesic Appalachian oak-hickory forest on the refuge is documented as an exemplary natural community, according to NHB. This community type includes a mix of Appalachian hardwoods, as described above, and "transitional" hardwoods, such as beech, birches, and maples. Hemlock and white pine occur in variable amounts in both forest types. The mesic oak-hickory forests tend to have a more diverse forest canopy compared to the dry oak forest. The mesic forest occurs in two variants, both of which occur on the refuge. The dry-mesic variant occurs on well-drained find sandy loam soils where beech, paper birch, and some dry-site herbs are more frequent. The mesic variant is more common on silt loam soils with more moisture, where white ash and black cherry might be more prevalent (Sperduto and Nichols 2004).

Oak forests were not dominant in the Northeast pre-human settlement. Burning by Native Americans may have increased oak dominance in certain forests. European settlement further increased oak dominance through logging, land clearing and the introduction of chestnut blight (Abrams 1992). Oak and hickory are early to mid-successional species that depend on fire or disturbance for regeneration. Abrams (1992) suggested a fire frequency of 50 to 100 years in pre-settlement oak forests to sustain oak species. Some of these forests may succeed to other overstory species in time due to lack of adequate red oak regeneration, and from increases in beech on drier sites and sugar maple and beech on more mesic sites. Repeated fire would tend to knock back fire-sensitive species like beech and sugar maple. As such, any natural, semi-natural, and/or controlled fire regimes may be necessary for the long-term maintenance of oak and hickory on some sites (Sperduto and Nichols 2004). However, projected changes to natural processes under climate change predictions (northward shift of ecosystems and increased likelihood of natural fires) may maintain this habitat.

Appalachian oak forests are important to many wildlife species given the abundance of nut-bearing oaks and hickories. These rich foods are eaten by wild turkey, white-tailed deer, ruffed grouse, squirrels and other small mammals, blue jays, rose-breasted grosbeak, and wood duck among other birds. The mature deciduous trees in these forests offer nesting sites for scarlet tanager, Baltimore oriole, and wood thrush, which are three species of conservation concern in this region. All three prefer deciduous or mixed mature forests. The oriole occurs in more open or semi-open wooded areas, while the wood thrush is found more commonly in mature forests with a denser understory of shrubs and sub-canopy trees. The scarlet tanager occurs across a broader range of mature forest understory conditions.

Bat surveys on the refuge from 2009 to 2011 detected several species of bats using the refuge both during migration and breeding period. Migrating species including northern myotis, eastern small-footed bat, little brown bat, big brown bat, and eastern red bat. Confirmed breeding species include northern myotis (most abundant), red bat, eastern small-footed bat, and big brown bat. Bats use forested areas for roosting and wetland areas for feeding. The loose bark of hickory species and other tree species in stages of decay provide breeding and migratory habitat for bats. The northern myotis and the big brown bat roost under tree bark and the red bat roosts in dead leaves in trees. Small-footed bats are found in rocky outcrops. Very little is known about the range, habitat, reproduction, and population size of bats in New England. In addition, recent dramatic declines in bats due to the white-nose syndrome raise the importance of Great Bay Refuge as potential habitat for breeding and migrating bats (see Shrub section for bat hibernacula and refugia at Great Bay). The Service is currently conducting a 90-day review for the listing of the northern myotis and eastern small-footed bat. To date, none of the bats caught at Great Bay has shown any signs of white-nose syndrome or wing damage. Much of New Hampshire's

Appalachian oak forest is lost to development and large intact stands are rare. The remaining oak-hickory forests have fewer large trees, less diverse understory vegetation, and little coarse woody material on the forest floor.

In the summer and fall of 2006, the Forest Service, Forest Health Protection Group, Durham Office, conducted a forest health assessment on the refuge. Their full report is included as appendix H. In general, the forest stands on the refuge are healthy. However, many stands inventoried were overstocked, large diameter stands. This forest condition is common in stands that have had no active management. In their assessment, the distribution of size classes is not balanced on the refuge and mature size classes are overrepresented. They report that there is a potential for overstocked stands to be less vigorous, more susceptible to pests, lacking adequate regeneration in the understory, and which may lead to the loss of moderate to intolerant shade species in future stands. Their report includes management recommendations. As indicated below under our strategies, we would continue to work with the Forest Service and other forest ecologists to develop specific treatments for managing the refuge's forests.

The 41-acre increase in the Appalachian oak-hickory forest habitat (as compared to alternative A) is based on our proposal to allow small (less than 3 acres) isolated patches of grassland and shrubland habitat, that are otherwise surrounded by trees and not providing quality grassland or shrubland habitat, to naturally revert to mature forest. This is expected to take at least 50 years. Over the next 15 years, however, we anticipate that those grassland patches would only succeed to a shrubland-type and existing shrubland would only succeed to a sapling-pole stand. Allowing these isolated patches to revert to forest over the long term would reduce edge effect from forest fragmentation, increase habitat for forest interior dwelling species of conservation concern, and reduce the amount of management-intensive habitat on the refuge.

Strategies

Continue to:

- Assess use of refuge's habitats by Indiana bats, eastern small-footed bats, northern myotis, red bats, and other tree bat species using acoustic monitoring and mist nets, and monitor refuge's population for white-nosed syndrome; focus assessment on large diameter trees which may be important summer roosting habitat.

- Complete a vegetation map for Fabyan Point and Thomas property and update the natural community map for the rest of the refuge.

Within 5 years of CCP approval:

- Allow an additional 41 acres of grassland and shrubland habitat to naturally succeed to forest (705 total acres) by discontinuing mowing for woodcock singing grounds.

- Work with forest ecologists to determine appropriate management techniques to sustain species diversity, forest structure, and ecological integrity of the oak-hickory forest community, and develop best management practices (e.g., prescribed fire, silvicultural practices, or passive management) to sustain a healthy oak-pine forest.

- Evaluate and develop management strategies for red pine, which occurs in 44 patches on 25 acres on the refuge. These pines are approximately 170 years old. According to Sperduto (personal communication, 2010) red pine start to die out between 170 to 200 years old and may need fire to regenerate, although no evidence of fire is apparent on these sites and they appear to be regenerating naturally.

- Survey for and locate potential roosting sites for bats species known to breed on the refuge (northern myotis, red bat, big brown bat, and eastern small-footed bat) using acoustic monitoring and radio tracking.

- Manage 25 acres of plantations (white pine, red pine, white fir, and white spruce) to ensure succession to oak-hickory forests and control any disease outbreaks.

- Complete inventory and mapping of invasive plants for the refuge.

Monitoring Components

- Re-visit the exemplary Appalachian oak-hickory forests identified by NHB in 1990 to assess their condition. Consult with NHB on this reevaluation. Evaluate the rest of the oak-hickory forest with these sites as reference.

- Monitor the red pine plantation by Woodman Point for successful regeneration, and manage (using prescribed fire) if necessary.

- Develop a long-term monitoring program to track the vegetative and wildlife response to climate change. Project topics may include phenology of plants and birds, species composition, hydroperiods of forested wetlands, and fire regimes.

- Survey forests and adjacent habitats for Indiana bats and other bats species. Use mist-netting and acoustic surveys during breeding, roosting, and migration periods to determine the presence and abundance of bat species. Also, search large diameter trees for bat activity, particularly in summer.

- Continue to partner with the Forest Service Research Station in Durham, New Hampshire to conduct forest health surveys annually.

- Annually, monitor the long-term effectiveness of invasive plant treatments.

Objective 2.2 (Forested and Scrub-Shrub Wetlands)

Maintain the biological integrity, diversity, and environmental health of 158 acres of forested and scrub-shrub wetlands within the larger matrix of oak-hickory forests and Peverly Brook drainage, to sustain high water quality and native vegetation such as speckled alder, spicebush, silky dogwood, and winterberry, to benefit foraging woodcock, breeding willow flycatcher, other birds of conservation concern, and native plant communities. Ensure less than 10 percent of total vegetative cover of invasive plant species. Wet forests and shrublands that contain functioning vernal pools will also be managed to benefit vernal pool obligate species of conservation concern, such as wood frog.

Rationale

We detail how we determined what elements comprise the biological integrity, diversity, and environmental health for each of the refuge's plant communities in appendix B (part 1.3). In summary, we reviewed historical conditions, site capability, the current regional landscape conditions, and the biological diversity on the refuge. We also considered natural processes and limiting factors which could potentially affect each plant community.

Approximately 13.5 percent of the Great Bay Refuge is forested or scrub-shrub wetland. As noted in chapter 2, approximately 81 percent of those wetlands are forested and 19 percent is scrub-shrublands. Vernal pools are an important habitat feature that is imbedded in these wetlands types.

In 2000, the NHB mapped the natural plant communities on the refuge. They identified four forested wetland community types:

(1) Black gum–red maple–basin swamp
(2) Seasonally saturated red maple swamp
(3) Red maple–elm–ladyfern silt forest
(4) Red maple–sensitive fern–tussock sedge basin/seepage

These forested wetlands are imbedded within the forest matrix and occur in a range of sizes from 0.27 acres to a 65-acre red maple swamp that is hydrologically connected to Stubbs Pond.

NHB mapped a mosaic of scrub-shrub habitats, including approximately 12 acres of "speckled alder basin/seepage shrub thicket." The moist, silty soils associated with this wet shrub community are particularly suited to alder thickets and hence potential foraging habitat for American woodcock. Moist shrublands are also habitat for several species of concern including willow flycatcher and blue-winged warbler, as well as many other migrating songbirds. Maintaining shrubland habitats in native shrub condition and controlling invasive shrubs requires active management.

Vernal pools are a critical component of these wetlands habitats as they support a wide diversity of species. Wood frogs, both spotted and blue-spotted salamanders, and fairy shrimp all depend on vernal pools. Several rare species including Blanding's and spotted turtles also use vernal pools as "stepping stones" as they move from one wetland to another. Black gum basin swamps and other seepages often function as vernal pools, which are essential breeding habitats for some species of amphibians and invertebrates.

A former refuge manager created a 1-acre wetland in 1995 by installing a wooden water control structure to impound several drainage ditches in the former Weapons Storage Area. This wetland holds water during the spring and early summer and goes dry during late summer. Cattails dominate this wetland and a few marshbirds were noted here such as sora and Virginia rails, and some frogs. Under alternative B, we propose to remove the water control structure and plug the ditches to create a wet shrub-meadow to benefit New England cottontail and several bird species of concern, as mentioned above. There is another 1-acre impounded wetland east of Stubbs Pond and adjacent to the large red maple swamp complex. This open water impoundment was likely created with the collapse of a culvert under the access road to Stubbs Pond.

Under this alternative, the amount of forested and scrub-shrub wetlands would increase approximately 9 acres from current levels due to the removal of the Lower Peverly Dam and restoration of a portion of Peverly Brook.

Strategies
Continue to:
- Complete the inventory and mapping of invasive plant species. Prioritize invasive species to be controlled and implement control using biological, ecological or cultural, mechanical, prescribed fire, or chemical, as needed.

- Evaluate the existing amphibian and reptile monitoring data, including the malformed frog surveys, to determine future monitoring needs.

Within 5 years of CCP approval:
- Maintain water control structure off Ferry Way Trail to prevent flooding by beaver.

- Inventory and map and assess the quality of forested and scrub-shrub wetlands, including vernal pool habitat and rare plants.

- Remove the water control structure from the 1-acre impoundment in the former Weapons Storage Area and plug the ditches to create wet shrub meadow habitat. Maintain the water control structure on the Ferry Way Trail as it prevents the trail from flooding by beaver.

- If the access road to Stubbs Pond is rehabilitated, install a culvert where the current impoundment is to restore hydrological flow on both sides of the road.

Monitoring Components

- Initiate a cover board project to inventory and monitor use of various habitats by salamanders and snakes. This project will measure presence, abundance, and use of habitat by these species.

- Evaluate the existing amphibian and reptile monitoring data, including the deformed frog surveys, to determine other future monitoring needs.

- Continue participation in the U.S. Geological Survey's Amphibian Research and Monitoring Initiative (ARMI) to monitor long-term population trends of vernal pool associated amphibians, including monitoring for water quality.

- Establish a monitoring program to measure vegetation and hydrology before and after removal of the water control structure in former Weapons Storage Area and near Stubbs Pond.

- Complete the inventory and mapping of invasive plant species. Prioritize invasive species to be controlled and implement control using biological, ecological or cultural, mechanical, or chemical as needed. Annually, monitor the long-term effectiveness of any treatments.

Objective 2.3 (Upland Shrubland)

Annually manage at least 54 acres of upland shrub habitat in three areas (former Weapons Storage Area, along McIntyre Road, and in the old orchard) to support native shrubs and young trees (e.g., highbush blueberry, black huckleberry, dogwoods, arrowwood, bayberry, meadowsweet, raspberry, sensitive fern, sumac, elderberry) and less than 25 percent cover of invasive plants, to provide nesting and foraging habitat for migratory birds of conservation concern including prairie warbler, blue-winged warbler, eastern towhee, American woodcock, New England cottontail and other thicket-dependent species.

Within 5 years of CCP approval, evaluate the feasibility of establishing a captive breeding and/or "hardening" pre-release site for New England cottontail on at least 37 acres of shrubland in the Weapons Storage Area. If determined feasible, manage these shrublands to provide preferred cottontail habitat which consists of dense native shrubs and vine tangles with a density of 20,000 woody stems per acre that are at least 20 inches tall and less than 3 inches in diameter. Work with partners to release captively bred young to suitable sites to reestablish or augment populations.

Within 5 years of CCP approval, experiment with modifying two to four bunkers, which lie within shrubland habitat, to provide bat hibernacula and refugia. Work with the Service's New England Field Office and partners to explore those opportunities.

Rationale
The refuge currently has approximately 26 acres of early successional shrub habitat that is reverting from previous management practices. Under alternative B, we propose to manage an additional 28 acres of shrubland habitat to benefit migratory birds and other shrubland-dependent species of conservation concern. This additional acreage is primarily is a result of active shrub management that would occur in the former Weapons Storage Area, which is currently grassland. Invasive species often quickly invade areas that are disturbed on the refuge, particularly grassland and shrubland areas. Autumn olive is particularly difficult to control as it quickly invades open land habitat. The shrub habitat provides nesting and foraging habitat for birds of conservation concern including prairie warbler, blue-winged warbler, eastern towhee, and American woodcock, and habitat for other thicket-dependent species. However, invasive plants also provide dense cover from predators needed by many of these species, particularly New England cottontail. When managing shrublands for birds and New England cottontail, we will balance managing for a native composition of shrubs while providing sufficient cover and food resources. This is particularly true for New England cottontail habitat in the former Weapons Storage Area, where some areas will initially be allowed to be re-vegetated by invasives while we restore a more native, higher nutritional shrub cover in other areas.

Shrublands and brushy old fields are critical wildlife habitats that are essential for the survival of many wildlife species. Of 40 bird species associated with shrubland habitats, 22 are undergoing significant population declines in eastern North America. Forest interior birds also use shrub habitats extensively during the migratory and post breeding period (Rodewald and Brittingham 2004, Vitz and Rodewald 2006, and Chandler 2007). Important habitat characteristics for both shrub nesting birds and bird use during migration are high dense cover, which provides protection from ground and aerial predators, and native fruit-bearing plants, which provide diverse high quality prey base (Vitz and Rodewlad 2004). Additionally, 139 species of reptiles, amphibians, birds, and mammals either prefer (17 species) or use (122 species) shrub and old-field habitats. Shrubland habitats in the Northeast also contain higher proportions of State-listed butterflies and moths than other natural community types. Of 3,500 species of butterflies and moths in the Northeast, 58 are dependent upon shrublands, which provide sunny open areas in combination with desired host plants such as scrub oak and blueberry. Fifty-six of these are considered rare (Tefft 2006).

Great Bay Refuge supports breeding habitat for several species of shrubland birds, including eastern towhee, prairie warbler, blue-winged warbler, and willow flycatcher. Shrub habitats on the refuge range from alder thickets (described under objective 2.2) to dry, old field conditions. In addition to its value to breeding birds, shrubland habitat is important because many other birds rely on it at various other times of the year. Many shrub species bear fruit in the fall, which helps boost the fat reserves for migrating and overwintering birds. Chandler et al. (2007) found that forest nesting birds preferred shrub habitat during the post-fledgling period, presumably due to its higher insect and fruit abundance. The loss and degradation of naturally maintained shrublands has been extensive throughout the region (Dettmers 2003). In Eastern North America over the last 60 years, open habitats (e.g., grasslands, savannah, barrens, and shrublands) have declined by 98 percent, with shrubland communities comprising 24 percent of this decline (Tefft 2006). Residential development, conversion to other land uses, and natural succession has contributed to the decline of shrub habitats. In southeastern New Hampshire, many shrub communities are now dominated by invasive plants.

The New England cottontail is a candidate species for listing under the Federal Endangered Species Act, and has declined significantly throughout its range. Litvaitis and Tash (2006) estimated the species only occupied 14 percent of its historical range as of 2004, with the population in New Hampshire and Maine persisting in highly developed, fragmented areas. Kovach and Fenderson (2010) found four major genetically distinct sub-populations:

- Maine/New Hampshire
- Cape Cod
- Connecticut/Rhode Island
- Connecticut/New York

All sub-populations face reduced fitness due to fragmentation, with the Maine/New Hampshire and Cape Cod population at the greatest risk of extinction. A fine scale genetic study in southern Maine found a drastic reduction in patch occupancy and range contraction from 1997 to 2007, and a 50 percent reduction in effective population size of some remnant populations in the same time period (Kovach and Fenderson 2010).

Strong partnerships are developing in the cottontail rabbit's remaining ranges to manage and restore shrub habitat. However, major barriers to dispersal and rapid loss of genetic diversity and extirpation of local patches indicate that reintroduction and augmentation within each genetically distinct population is a necessary tool for the survival of this species. There is an ongoing effort at the Roger William Zoo in Rhode Island to captive breed and rear New England cottontail. To date, seven rabbits have been taken into captivity from Connecticut. Due to the necessity to maintain separation among the four distinct populations, the zoo does not have the capacity to supply rabbits throughout its range.

We have been in discussion with partners regarding the potential for managing a captive rearing facility in the bunker area of the former Weapons Storage Area. This would increase the amount of shrub habitat that currently occurs on the refuge by approximately 30 acres. The former Weapons Storage Area is currently fenced, which would facilitate cottontail management. Another benefit of shrub management is to conceal the existing bunkers. These bunkers are an eyesore in an otherwise natural landscape and cannot be reasonably removed without extensive disturbance and expense. A captive rearing program on the refuge would be similar to that implemented for the riparian brush rabbit in the San Joaquin Valley of California, where founder rabbits are rotated through the facility at 6 to 12 month intervals, and then placed in the wild. We would also consider using the area for "hardening," a process in which captively breed rabbits are slowly acclimated to natural conditions prior to being released into the wild.

The refuge does not currently have sufficient shrub habitat to support a viable population of New England cottontail, even over the short term. However, we are exploring the option of working with partners to coordinate the protection of a significant population off-refuge in the Dover, New Hampshire area.

The majority of bat species are facing unprecedented threats to their population due to white-nose syndrome. The disease was first detected in a cave in New York in 2007. Since then, it has spread to 13 U.S. states and 2 Canadian provinces, from ranging from Newfoundland, West Virginia to Indiana. In 2011, it was also detected in three additional states (Oklahoma, Delaware, and Missouri), however no deaths associated with white-nosed syndrome has been detected in those states to date.

Researchers suspect that a cold-loving fungus (*Geomyces destructans)* is cause of the disease. The fungus appears to disrupt normal patterns of hibernation, causing bats to arouse too frequently from torpor and starve to death. Staggering mortality rates (greater 90 percent in some caves) have pushed even some of the most common species to risk of extinction. Frick et al. (2010) predicted that little brown bats could be extinct in 20 to 60 years. The Service is currently reviewing the northern myotis and eastern small-footed bat for Federal listing (75 FR 38095).

In response to this threat, the refuge is collaborating with numerous partners, including the Service's New England Field Office, NHFG, and other states and refuges, to conduct a pilot study to adaptively modify two to four bunkers on the refuge to provide suitable hibernacula for bats. The pilot study involves monitoring temperature and relative humidity in the bunkers while we increase insulation and humidity in the bunkers using a wide range of techniques. Bats use military bunkers at other sites in New England, including those at Odione State Park in Rye, New Hampshire. By modifying additional abandoned military bunkers to suitable hiberacula, we can

- provide alternative refugia/hibernacula to surviving bats or non-affected bats;
- minimize spread of disease by disinfecting hibernacula after bats leave;
- use bunkers as experimental chambers to eradicate white-nose syndrome or lessen its impact on infected bats.

Bat species that might use these bunkers include big brown bats, little brown bats, northern myotis, and eastern small-footed bat. All species of these are known to occur on Great Bay Refuge during the breeding and migratory season. Northern myotis are the most common species on the refuge.

There are two other shrubland units on the refuge. The first is the 14-acre unit by MacIntyre Road that has sandy soils and supports primarily shrub species. This site could potentially support the State-listed endangered northern blazing star and the State-listed threatened hairy hudsonia. Both plants occur on abutting airport lands. Although these species do not currently occur on the refuge, this is a potential site for reintroduction. The blazing star occurs in sandplain grasslands and other dry, open habitats and may require prescribed fire. The hairy hudsonia also requires sandy areas. The other shrub unit is an old 3-acre orchard directly west of the MacIntyre Road unit. It would continue to be managed as an open orchard for wildlife observation.

Under alternative B, as noted above, the overall shrubland habitat acreage on the refuge would increase by at least 28 acres due to active management in the former Weapons Storage Area on areas which are currently in grassland. However, it is also important to note that a few smaller shrubland habitat patches would succeed to forest. These patches, all less than 3 acres, are either embedded in, or immediately adjacent to, large forest patches. Because they fragment the existing forest, and/or create additional edge habitat when contiguous forest habitat is a priority on the refuge; they do not provide valuable wildlife viewing opportunities; and, they are not efficient to manage from an administrative perspective, we propose to allow them to succeed to forest. Management activities would be minimal in those shrublands, and likely only need to occur to manage invasive plants or pests.

We may allow additional acres of 37 acres of grasslands in the former Weapons Storage Area to revert to shrubland if

- upland sandpipers do not breed in this field within 3 to 5 years, and;
- no other grassland species of conservation concern would benefit from those grasslands.

We would also likely continue to manage some of the former Weapons Storage Area as grassland for wildlife-observation opportunities and administrative purposes (see objective 2.4).

The proposed shrub management areas are depicted on map 3.8.

Strategies
In addition to alternative A and within 5 years of CCP approval:

- Use adaptive management to modify two to four bunkers to achieve ideal hibernation conditions for cave-dwelling bats (constant temperature above freezing and relative humidity of 80 to 100 percent from late August to May). Potential strategies include the following:
  - Closing and insulating the door of the bunkers
  - Scraping soil on top of bunkers and adding rigid insulation
  - Plugging up drainage ditches and adding water (small pools or water pumps) to increase moisture in bunkers
  - Installing bricks and cinder block walls for added thermal regulation and hibernating surfaces
- Determine what ecological integrity components should be monitored as part of the managed shrub community and develop a management plan that would sustain the 54 acres on an approximately 15-year rotation.
- Complete the inventory and mapping of invasive plant species. Prioritize invasive species to be controlled, and implement control using biological, ecological or cultural, mechanical, prescribed fire, or chemical methods as needed.
- Establish partnership with scientists at Boston University to identify and conduct various research projects involving bats and bat ecology.
- Develop a restoration and monitoring plan for the bunker areas at the south end of the former Weapons Storage Area and the areas abutting this site outside the fenced former Weapons Storage Area as a shrub community totaling approximately 37 acres or more, using the brontosaurus or other mechanical tools, and native plantings as needed. Incorporate monitoring protocols and adaptive management techniques gained from the Regional Shrub Adaptive Management Project led by Parker River Refuge biologist.
- Collaborate with NHFG and UNH to determine feasibility of New England cottontail captive propagation for reintroduction to other areas in the region.
  - If found feasible, maintain the existing Weapons Storage Area fence around the proposed native shrub management area to provide safe habitat (free of mammalian predators) for New England cottontails. Shift rest of fence to create exclosure at north end of shrub management area.

- If right conditions achieved for hibernating bats, work with partners to develop a plan to attract bats and manage and/or experiment with different ways to address white-nose syndrome.

- Develop a shrub restoration partnership to propagate native species and work with local contractors to select and transfer dominant shrubs from development sites.

- Determine the distribution and management needs of northern blazing star and hairy hudsonia, and evaluate potential habitat for reintroduction of northern blazing star. If potential habitat is located and reintroductions are possible, develop survey and monitoring protocol for reintroduced populations.

- If upland sandpipers do not nest in the grassland portion of the former Weapons Storage Area within 3 years of creating suitable habitat, let majority of grassland (30 to 35 acres) revert to shrub habitat.

Monitoring Components

- Identify and treat invasive plant populations using early detection rapid response methods and monitor the long-term effects of treatments.

- Monitor the density and plant composition in the shrub habitat blocks every 5 years to assess management needs.

- Monitor breeding and migratory bird use of shrub habitat after successful establishment and every 5 years as part of breeding bird point surveys. Data collected will include presence/absence and abundance.

- Monitor for other shrub-dependent species, such as black racer and smooth green snake, using the cover board technique or other established protocols.

- Monitor modified bunkers to obtain suitable conditions for hibernating bats (temperature and relative humidity on an hourly to daily basis). If ideal conditions are established, work with partners to continue to monitor conditions and develop an additional strategy for monitoring strategy bat use in the bunkers. Within 2 years of achieving ideal conditions, work with partners to establish a plan for ongoing research on hibernating bats in bunkers.

Objective 2.4 (Grassland)

Annually manage the Thomas Field (39 acres) to maintain a mix of grass and herbaceous vegetation at mixed heights ranging from 8 to 24 inches during the summer, with minimal thatch build-up, less than 15 percent of total vegetation of woody species and greater than 5 percent bare ground, to provide nesting habitat for upland sandpiper and other grassland species of conservation concern.

Annually manage the former Weapons Storage Area (38 acres) similar to the Thomas field. If upland sandpipers do not breed in this field within 3 to 5 years, and no other grassland species of conservation concern would benefit from those grasslands, determine whether to allow the Weapons Storage Area field to revert to shrubland. Include in that determination whether to maintain a small portion of grassland in the northwest corner for wildlife observation and cultural interpretation.

Manage the Woodman Point Field (15 acres) to maintain a mix of grassland herbaceous species as nesting habitat for bobolinks, singing habitat for woodcock, and migration habitat for Lepidoptera and other species of conservation concern. Manage the Ferry Way Trail grassland unit (6 acres) primarily to provide habitat diversity for wildlife viewing along the trail and also to support singing

habitat for woodcock and migration habitat for Lepidoptera and other species of conservation concern

Rationale
In 2005, refuge staff were managing 21 treatment areas as grasslands for nesting birds and other wildlife, primarily in the former Weapons Storage Area, at Woodman Point, along the refuge road, along Ferry Way Trail, and adjacent to the Thomas Farm. Many of these grassland areas have a component of little bluestem, as well as nonnative grasses. The largest grassland, approximately 70 acres, is in the former Weapons Storage Area. This grassland complex is managed using prescribed fire and mowing to control autumn olive and other woody plants. The 30-acre Thomas field and 24-acre Woodman Point Field complex are mowed and hydro-axed. The remaining grassy areas range from 2 to 4 acres in size and are mowed every 1 to 2 years to benefit woodcock. Since 2008, seven of these treatment areas have been allowed to revert to shrub or forest habitats.

Northeastern grasslands have provided habitat for grassland birds and other wildlife for hundreds of years. Historically, most of northern New England was forested with grasslands generally restricted to scattered small openings along river floodplains, wetlands, and beaver meadows. However in southern New England early settlers described more extensive openings including coastal sandplain grasslands, heathlands, and openings maintained by Native Americans. By the 1800s, grasslands were widespread throughout the region and grassland birds such as grasshopper, savannah, and vesper sparrows, upland sandpipers, eastern meadowlarks, and bobolinks were thought to be prevalent. By the late 1800s grasslands were declining as farms were abandoned, existing farms changed their use of the land, and fire was used less. More recent human development has consumed many remaining open fields. Remnant patches of grasses remain throughout the Northeast along railroad grades, rivers, roadsides, cemeteries, pastures, old fields, and reverting farmlands (Capel 2006).

Grassland bird species recorded during surveys on the refuge from 2001 to 2003 included eastern meadowlark, bobolink, upland sandpiper, field sparrow, red-winged blackbird, American kestrel, and vesper sparrow. Brown thrasher and eastern towhee, two shrubland species, were also recorded. In 2003 and 2004, at least one pair of upland sandpipers was observed using the former Weapons Storage Area and the Thomas field during the nesting season. The Thomas Field pair was observed nesting for the second year in a row.

In the NHWAP (NHFG 2005), "extensive grasslands" are defined as areas greater than 25 acres(10 hectares) dominated by grasses, forbs, and sedges with little shrub or tree cover. Large grasslands are particularly important, since many grassland birds require large areas for nesting. The State-listed endangered upland sandpiper, for example, typically requires over 150 acres of grassland that supports a mix of short (greater than 8 inches) and tall (up to 24 inches) grasses for foraging and nesting, respectively. They also need taller structures—fence posts, signs, tall mullein—as singing perches. Many of the remaining large grasslands in New Hampshire are restricted to hayfields, cropland, airports, capped landfills, and military installations, places that do not have wildlife habitat as a primary objective and in some cases may be in conflict with wildlife management (NHFG 2005). The airfield at the Tradeport, adjacent to the refuge, has supported a population of 8 to12 nesting pairs of upland sandpipers on its 500 to 600 acres of grasslands since 1989. As this is the State's only extent breeding population, the Tradeport and NHFG seek help in managing a second population of upland sandpipers on refuge land. The species has been sighted at several other locations in New Hampshire including Dover,

Manchester, and southern Coos County (P. Hunt and D. De Luca, NH Audubon, personal communication with refuge manager).

Given the regional decline of grassland habitats, the refuge can play an important role in maintaining several large blocks of this habitat. Here, the Service has the capacity to annually manage these habitats to benefit species of conservation concern. The refuge has two sites that lend themselves to managing large blocks of grassland habitat: the north end of the former Weapons Storage Area and the Thomas Field at the south end of the refuge. Although both sites are smaller than the 150-acre minimal patch size, upland sandpipers have nested in both fields in the past, and are known to prefer grassland adjacent to airports (USGS 2006).

Two additional sites would also continue to be managed as grassland under alternative B. The Ferry Way Trail grassland unit is 6 acres and would be managed to provide a popular and high-quality wildlife viewing opportunity for the public. The 15-acre Woodman Field includes a diverse mix of grasses and flowering herbaceous species.

Another potential area to consider for future grassland management is a 15 to 20 acre field on the northern boundary of the refuge, north of the Ferry Way Trail. A small little blue stem field has persisted there since prior to 2000 (mapped by NHB) without any management. Additionally, the soils adjacent to this small grassland, including the 15-acre pine plantation, are very sandy and suitable for grassland management. Although these grasslands would not be suitable for upland sandpipers, other wildlife species of conservation concern would benefit including bobolink, northern leopard frog, smooth green snake, as well as a host of butterflies, moths, spiders, bees, and other insects (NHFG 2005).

As presented in table 3.1, under alternative B, grassland acres would be reduced from 169 acres to 98 acres. Of that 71 acre reduction, 28 acres of grassland would be actively managed as shrubland in the former Weapons Storage Area, thus continuing to provide early successional habitat. The remaining 43-acre difference would be allowed to revert to forest for reasons similar to those we presented for shrublands. In summary, we would propose to allow fields to revert to forest if

- they fragment the existing forest;
- create additional edge habitat when contiguous forest habitat is a priority on the refuge;
- they do not provide valuable wildlife viewing opportunities; and/or
- they are not efficient to manage from an administrative perspective.

Management activities would be minimal in the area allowed to revert to forest, and likely only need to occur to manage invasive plants or pests.

The proposed grassland management areas are depicted on map 3.8.

Strategies

Within 2 years of CCP approval:

- Complete the inventory and mapping of invasive plant species. Prioritize invasive species to be controlled and implement control using biological, ecological, mechanical, or chemical methods, as needed.

- In conjunction with revising the HMP, develop best management prescriptions (e.g., mowing, burning, frequency, seeding, haying, disking, etc.) for maintaining grass-dominated fields of variable sizes as indicated below.

- Enhance the habitat quality of the two larger grassland habitats (39-acre Thomas field and 38-acre former Weapons Storage Area field) for upland sandpipers through annual mowing, burning, and/or other management tools after grassland bird breeding season (August 1). Consider management options that would also benefit pollinators.

- Similarly, manage the Woodman Field (15 acres) as nesting habitat for bobolink, singing grounds for American woodcock, and as migration habitat for Lepidoptera.

- Evaluate site capacity (including soil and hydrology) of all non-administrative grassland units to determine ideal plant species composition and structure, use of management tools such as fire and mowing; and restore to shrub or forest if site is not suitable for grassland management. Evaluate site capacity of shrub unit by MacIntyre Road and the pine plantation by the refuge's northern boundary to be managed as grassland habitat for pollinators, bobolinks, and singing ground for American woodcock.

- Mow the (6 acres) fields along the Ferry Way Trail for early successional species such as pollinators, raptors, and landbirds as well as a wildlife viewing site for visitors.

- Allow eight patches of shrub and grassland openings in the forest to revert to forest to reduce forest fragmentation.

- Except as discussed elsewhere under historic resources, remove any remaining structures. Within the former Weapons Storage Area this would include all above ground structures and possibly the bunkers.

- Partner with New Hampshire Audubon and NHFG to develop methods for enhancing habitat for upland sandpipers on the refuge.

Within 5 years of CCP approval:

- Remove remaining Weapons Storage Area fencing and remaining military structures in the grassland management area. Remove hedgerows and small woodlots at the Thomas Field to enlarge the grassland area.

- Complete the inventory and mapping of invasive plant species; prioritize invasive species to be controlled and implement control using biological, ecological or cultural, mechanical, or chemical as needed.

Monitoring Components

- Continue to monitor breeding birds in the refuge's grassland habitats, according to regional protocol, to determine population trends, density, and use by grassland obligate species (e.g., upland sandpiper).

- Develop monitoring protocol and establish parameters to determine success for restoration of grassland habitat (for upland sandpipers) and for restoration of grasslands to shrub or forested habitat.

GOAL 3. **Foster and maintain conservation, research, and management partnerships to promote protection and stewardship of the ecological resources of the Great Bay Estuary.**

Objective 3.1 (Great Bay Resource Conservation, Research, and Management Partnerships)

Maintain and expand current key partnerships to promote land conservation, stewardship, research and management of resources of concern within the Great Bay Estuary. These partnerships include the Great Bay Resource Protection Partnership, Piscataqua Region Estuaries Program, Coastal Watershed Invasive Plant Partnership, Pease Development Authority Wildlife/Bird Strike Hazard Committee, and the New England Cottontail Working Group, among others.

Rationale
GBRPP is a coalition of public and private conservation groups that formed in 1994 to help protect the remaining important habitats within and around Great Bay. GBRPP takes a comprehensive, landscape-scale approach to conservation and habitat protection by developing and implementing conservation strategies through a combination of scientific field studies and ongoing communication with local, regional, State, and national conservation representatives. Parker River Refuge's refuge manager attends the quarterly meetings of the GBRPP. Since 1996, the partnership has protected over 5,000 acres of habitat around Great Bay.

In 1992, a MOA was signed between the Service, Federal Aviation Administration, U.S. Department of Agriculture–Animal and Plant Health Inspection Service), and Pease Development Authority. The MOA calls for coordination and quarterly meetings among the parties to review and discuss past and future wildlife management practices by the Service on the refuge and Pease Development Authority at the airport; the effects of such management practices on airport operations and on Service trust resources; and airport facility aircraft operations and their potential effects on the refuge (MOA 1992). This group is referred to as the Wildlife/Bird Air Strike Hazard Committee. Current issues include managing upland sandpipers that nest on the airport, impacts of large birds, such as wild turkeys, on the runway, and addressing potential impacts to the refuge from new de-icing pads and other sources of runoff.

As previously mentioned, Great Bay Refuge is a "sustaining partner" of CWIPP, a partnership among 11 agencies and organizations concerned with the effects of invasive plants within New Hampshire's coastal watershed. The goal through this cooperative effort is to achieve better management of invasive plants while improving working relationships between the signatories and the public.

We would also expand our partnerships to include the New England Cottontail Working Group, as well as partnerships with local land trusts and other private land management cooperatives in the region who have a goal to conserve lands of high resource value to Federal trust species.

Strategies
Continue to:
- Be an active member of GBRPP and serve on the Principal Partnership and Stewardship committees.
- Participate on the Pease Development Authority Wildlife/Bird Airstrike Hazard Committee.
- Serve on the PREP Management Committee.
- Participate in oil spill response training and coordination. One important reason to stay current on these skills is as a precaution in the unlikely event that an accident occurs with the shipping traffic up the Piscataqua River.

- Partner with the town of Newington, NHFG, and regional Service personnel on law enforcement on and around the refuge.

- Attend CWIPP meetings and actively participate in coordinated invasive control and outreach efforts.

Within 2 years of CCP approval:

- Facilitate research on the refuge, with focus on research that supports management goals and objectives, such as groundwater studies, hydrology, land use change impacts, habitat management, and habitat restoration.

- Work with the New England Cottontail Working Group to implement habitat improvements and opportunities for cottontail recovery. Evaluate the feasibility to propagate and restore New England cottontails to the refuge, specifically within the former Weapons Storage Area.

- Support research by partners in the Great Bay Estuary on conservation and management of eelgrass and oyster restoration, Great Bay water quality, and other topics that are linked to the refuge's goals and objectives.

- Identify refuge research needs and establish links with partners who can assist the refuge in researching these management questions; specifically, partner with the GBNERR and the National Estuarine Research Reserve's Science Collaborative.

- Work with Service's Ecological Services Private Lands Program to identify and evaluate projects that would support or enhance refuge goals and objectives and provide other resource assistance when possible.

Within 5 years of CCP approval:

- Enhance and strengthen collaboration with UNH's Jackson Lab in research and restoration of the Great Bay Ecosystem, particularly with restoration of eelgrass and oyster beds, salt marsh research, and monitoring water quality in the bay.

- Work with partners around Great Bay to create habitat management demonstration areas on the refuge and partner lands, including demonstration of invasive species control, grassland and shrubland management, dam removals, and oyster bed restoration.

- Facilitate technical workshops pertaining to the demonstration areas.

- Become a signatory to the CWIPP agreement.

Within 10 years of CCP approval:

- Establish partnership with Pease and Great Bay Country Clubs to develop management plans for their lands that contributes to the goals and objectives of the refuge and local conservation partnerships.

Monitoring Component

- The Air Force will continue its long-term groundwater well monitoring on the refuge to monitor water quality impacts from previous military uses. Obtain and interpret the results of this monitoring relative to refuge management. Adapt management practices accordingly.

- Develop a long-term monitoring plan to help identify and remediate (as feasible and necessary) potential offsite source of pollution that could negatively impact the refuge.

Objective 3.2 (Landscape-scale Conservation Partnerships)

Over the next 15 years, expand partnerships to address the refuge's role in landscape-scale conservation issues including climate change, regional population trends, research priorities, land use changes, and water quality.

Rationale

GBNERR is also a member of the GBRPP and the boundary of the reserve encompasses Great Bay Refuge. The Research Reserve System recently established a science collaborative, to fund collaborative, science-based projects that address coastal management issues. The priority research areas include impacts of land use change, habitat change and restoration, estuarine contamination, and stormwater and nonpoint source pollution management. The GBNERR is specifically interested in water quality, land use change, biological communities, and climate change. The Service is interested in collaborating with the reserve and other researchers on many of these issues.

In 1999, the Service launched the nationwide Land Management Research and Demonstration (LMRD) Areas "…to facilitate development, testing, teaching, publishing, and demonstration of state-of-the-art management techniques that support the critical habitat management information needs for fish, wildlife, and plant conservation within the System and other lands" (USFWS 1999). Two LMRD areas were established in our region: the Northern Forest LMRD and the Coastal Salt Marsh LMRD. Partnerships are a key element of demonstration areas. The Great Bay Refuge will partner with other participating national wildlife refuges, State and Federal agencies, universities, and others to further research on and off the refuge to advance our understanding of wildlife habitat concerns in the northern forest and coastal salt marshes.

The greatest effects of climate change will be on regional air and water temperatures, precipitation patterns, storm intensity, and sea levels. These effects are predicted to influence natural disturbances by resulting in an increase of freeze-free periods, decreased snow cover, increased storm intensities and frequencies, increased likelihood and frequency of droughts, damaging ozone, and an increase in the spread of invasive species and disease (NHFG 2005). The resulting effects on wildlife and habitats are expected to be variable and species-specific, with a predicted general trend of ranges shifting northward. The uncertainty about the future effects of climate change requires managers to use adaptive management to maintain healthy ecosystems in light of that unpredictability (Inkley et al. 2004). Tidal marshes are among the most susceptible ecosystems to climate change, especially rapid sea level rise. The refuge expects to partner at all levels—around Great Bay, within New Hampshire, regionally and nationally—to address this immense conservation challenge.

Strategies

Within 5 years of CCP approval:

- Conduct a research needs assessment for the refuge. Emphasize research projects that evaluate our assumptions, objectives, strategies, and techniques on species, habitat, and ecosystem management.

- Develop information exchange for research. Seek research partnerships to foster collaborations across the region.

- Collect information that contributes to regional information needs such as winter banding of waterfowl to help define populations.

- Identify the role of the refuge in contributing to the Service's 5-Year Action Plan on climate change and support similar initiatives in the NHWAP and NHCP.
- Participate in and support the priorities of the North Atlantic LCC.
- Collaborate with GBNERR on monitoring sea level rise as part of national effort. Assess feasibility of having reserve install a sediment elevation table (SET) in the refuge salt marsh.
- Work with PREP to support the EPA climate ready estuary project; Work with GBNERR and Great Bay Stewards to develop and outreach impacts of human land use and climate change on the bay's resources, and facilitate implementation of mitigation measures by the bay's residents and visitors.
- Establish a partnership with UNH and the Jackson Lab to work with the refuge in addressing research needs.

Monitoring Components
- Continue to participate in regional ecological studies, such as malformed frog surveys, land bird monitoring, frog call surveys, analyses of mercury in fish, and invasive plant distribution surveys and control methods.
- Collaborate with the Service's Regional Inventory and Monitoring Program and our Great Bay partners to monitor long-term trends associated with climate change and effectiveness of mitigation measures.

Objective 3.3 (Education and Outreach Partnerships)

Within 5 years of CCP approval, support and coordinate with area environmental education facilities such as the Great Bay Discovery Center and the Seacoast Science Center, as well as area schools, to advance wildlife conservation and refuge goals.

Rationale

Similar to many refuge programs, partnerships are key to successful environmental education and outreach. Specifically, refuge staff have partnered with the YCC, STEP, and SCEP programs and the Phillips-Exeter Sustainable Program to complete projects on the refuge. The students gain valuable experience and the refuge completes much needed management activities.

By collaborating with and supporting area environmental centers, including local schools, the refuge can affect a wide range of environmental education opportunities. The Great Bay Discovery Center, on the shores of Great Bay in Greenland, serves as the conservation-education headquarters for GBNERR. Their facility offers interpretive displays, meeting space for workshops, outdoor interpretive trails, and reaches people of all ages with stewardship messages. Likewise, the Seacoast Science Center has many similar features. By working together on stewardship messages, and sharing resources where feasible, we can multiply our individual efforts into a more effective collective effort to promote environmental stewardship in coastal New Hampshire.

Strategies

Continue to:
- Partner with YCC program.
- Use the STEP and SCEP to mentor students and achieve refuge goals and objectives.

- Help CWIPP develop fact sheets on priority invasive species.
- Collaborate with Phillips-Exeter Academy students to complete refuge projects.

Within 2 years of CCP approval:

- Add Web site link to GBNERR and other relevant links (such as Save Great Bay on Coastal Program Web site) on the Great Bay Refuge Web site.
- Work with the GBRPP to create regional recreational access information and maps that highlight locations around the bay where recreational activities can occur, especially those not available on the refuge such as kayak/canoe launch points.
- Collaborate with the Great Bay Discovery Center and GBRPP on educational and interpretive programs, materials, and maps; share outreach messages.
- With partners develop stewardship outreach material and program to reduce pollution and fertilizer runoff from residential and commercial facilities.
- Collaborate with local schools, GBNERR, and Gulf of Maine Institute (GOMI), to establish a coastal environmental stewardship and advocacy team with high school students in New Hampshire (see Newburyport, Massachusetts high school team as example and other GOMI-sponsored team).
- Seek a volunteer willing to coordinate the volunteer program to improve organization, recruit new volunteers, and help prioritize and implement work.
- Create an orientation program for all volunteers and expand volunteer corps.
- Work with the Pease Development Authority and Great Bay Stewards to establish a Friends of Great Bay Refuge group.
- Partner with the New Hampshire Office of Tourism, New Hampshire Department of Transportation, Pease Development Authority, and others to provide information on the refuge, including signs, maps, and directions to the refuge.

GOAL 4.

Promote enjoyment and awareness of the Great Bay Refuge and Great Bay Estuary by providing high-quality, compatible, wildlife-dependent public uses on refuge lands and on partner lands and waters around the refuge.

Objective 4.1 (Wildlife Observation and Photography)

Provide enhanced high quality wildlife observation and photography opportunities by improving the refuge's two existing trails and pursuing new self-guided opportunities on Fabyan Point.

Rationale

The Refuge Improvement Act of 1997 identified wildlife observation and photography as two priority public uses for national wildlife refuges, along with environmental education, interpretation, hunting, and fishing. In 2006, the Service's regional visitor services team identified wildlife observation and photography as areas of emphasis for Great Bay Refuge.

As an unstaffed refuge, we have had limited ability to conduct a vibrant visitor services program. Despite these limitations, the refuge is popular, especially for birders and walkers. The refuge is open from dawn to dusk, with vehicle access controlled by a timed gate along Arboretum Drive. The trails are for foot traffic only. The Peverly Pond Trail is wheelchair accessible. Bicycles and motor vehicles are limited to the entrance road and parking lot. Pets are only allowed in the